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Critical Incidents in the Behavior of Secondary School Physical Education Instructors

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Abstract

The purpose of this study was to identify and classify incidents judged to be characteristic of effective and ineffective teaching in secondary school physical education. The method known as the critical incident technique was employed. Several samples of pupils and educators were asked to describe specific incidents illustrating particularly effective or ineffective behavior on the part of instructors recently observed. The major areas into which critical behaviors were grouped are administrative, instructional, social, and personal. While the characteristics of effective and ineffective teaching as reported by the various student groups were found to coincide consistently, there was a significant difference between behaviors furnished in the student and educator samples.

IT WAS the purpose of this study[1] to identify and classify incidents judged to be characteristic of the effective and ineffective direction of learning in secondary school physical education.

The study proceeded on the assumptions that: 1. teaching in the field of physical education is a function of the overt behavior of the instructor; 2. some overt behaviors may be critical to the teaching process; 3. such critical behaviors may be categorized and classified; and 4. reports of critical incidents reported by members of groups able to observe physical education teaching may be analyzed to designate such behavior.

The following hypotheses were adopted for the purposes of the current study: 1. that critical behaviors characterizing generally effective and ineffective physical education instruction are qualitatively distinguishable; and 2. that reports of critical behaviors of physical educators do not differ significantly among various groups of observers.

Definition of Terms

The following terms, pertinent to the study, are defined for the clarification of the succeeding discussion.

1. *Critical behaviors* are those which have been found to make the difference between success and failure in carrying out an important part of a specific assignment (2).

---

[1]This study was made for a doctoral dissertation completed under the guidance of Professors David G. Ryans and Ben W. Miller, University of California, Los Angeles, 1957.

2. A *critical incident* is one that occurs "in a situation where the purpose or intent of the act seems fairly clear to the observer and where its consequences are sufficiently definite to leave little doubt concerning its effects" (1).

3. The *critical incident* technique consists principally of the collection and analysis of behavior descriptions from members of the group studied (2).

4. *Critical requirements* are those qualities which have been observed to make the difference between success and failure in a significant number of cases (1).

5. The *category* or *fourth level* of generalization represents the initial stage of inductive classification in this study, in which the most similar behaviors reported by students and educators are grouped.

6. The *class* or *third level* of generalization is a slightly more general grouping derived by combining categories according to the similarity of their characteristics.

7. The *sub-area* or *second level* of generalization is developed by the further formulation of the pattern from the behavioral classes.

8. The *area* or *highest level* of generalization represents the broadest phase of teacher behavior as reported in this study and is obtained by merging the most closely related sub-areas.

The need for this investigation was suggested by: 1. recent studies along similar lines regarding class-room teaching and other occupations; 2. the potential value of determining, in behavioral terms, the characteristics of effective teaching in physical education; 3. a dearth of pertinent literature relating specifically to physical education; and 4. the desirability of providing a foundation for continuing appraisal in the profession.

Procedure

The method known as the critical incident technique, developed by John C. Flanagan and his colleagues at the American Institute for Research, has been employed in this study. It is based upon on-the-spot observations of behavior and its results. Such reports should be made within an interval of time sufficiently brief to eliminate, to a great extent, errors of memory.

Further, it is desirable that large samples of all groups considered competent to judge the behavior observed be employed to contribute to the production of a comprehensive and reasonably objective definition of requirements (8). Although complete objectivity has yet to be reached, such a method as the critical incident technique begins to approach that goal. This objectivity, as well as its diversity of application, commends the technique for this and other research.

Several samples of volunteer educators and their pupils were asked to describe specific incidents which illustrate particularly effective or ineffective behavior on the part of physical education instructors recently observed. Forty-nine educators, including physical education teachers, principals, su-

pervisors, and co-ordinators of college student teaching activities in physical education, and 1,619 pupils participated as observers in the current study. They represented three school districts and a teacher preparation institution in Los Angeles County, and in all, five senior and four junior high schools contributed reports.

The data were collected by means of a booklet in which three questions were asked each respondent with regard to his report on an instance. The first asked for the setting: time, place, and whether or not the reporter himself were involved. The second was concerned with the action itself ("What did the teacher do?"). The third item requested the respondent to state why the instructor's action was a good one or a poor one. It was the intention of the writer to provide as brief a statement of background as possible, consistent with the aim of furnishing each respondent sufficient knowledge of the technique. Therefore, brief letters of introduction to the student and to the educator, respectively, were included in the booklet.

Because of the possibility of group differences among districts, it was decided to treat the pupil reports obtained as three separate samples or replications in the investigation. Therefore, each step in the treatment of the data was performed individually for the district groups.

The behaviors contained in the reported critical incidents were classified by the inductive formulation of categories. Similar behaviors were processed into categories of behavior and these, in turn, into classes, sub-areas, and major areas. Each step involved grouping from the specific to the more general. Among the categories produced were "organization of squads" and "grading on a class curve." Examples of behavior classes are "used advanced students to instruct others" and "failed to render proper first aid and comfort." "Creation of a free or democratic atmosphere" and "imposition of an autocratic atmosphere" were two of the subjects formulated, while the four major areas of behavior, as determined from this study, were administrative, instructional, social, and personal.

The behaviors reported by the members of the various samples were classified separately, in order to prevent the investigator from attempting to force different data into a pre-determined plan conceived from any other set of data.

When the outline had been formulated for each sample, the individual behaviors reported in each incident were then placed in their most appropriate classes. Their incidence was then tallied. Statements of critical requirements were prepared at the third level of generalization, that is, the *class*, which is one step more specific than the outlines to follow.[2]

The reports of the three major student samples were analyzed for the possible significance of their differences at the second, or *sub-area*, level in

[2]More detailed outlines of critical behaviors, to be found in the original dissertation, will be supplied on request.

order to test one of the hypotheses employed in this study. Since the differences found were of little or no significance, a student consensus sample, involving the combination of pupil reports from all three districts into a single large sample, was formed. Then, this consensus of reports was treated in a fashion similar to that of its components and, further, treated against the data furnished by the educator sample.

Results

The results of this crtical incident study are summarized as follows:

1. The outline of the critical requirements for secondary physical education teaching, stated in terms of effective teacher behavior, as determined from the student consensus, numbered 85 behavior classes, while there were 94 classes of behavior of an ineffective nature.

2. The critical behaviors reported as effective by pupils were capable of classification under the following common sub-areas:

I. Administrative behaviors.
   A. Administered and organized the program adequately.
   B. Handled equipment and supplies efficiently.
II. Instructional behaviors.
   A. Provided effective instruction in physical education skills and activities.
   B. Offered capable instruction and activity in healthful living.
   C. Participated properly in the instructional program.
   D. Evaluated the learning situation fairly.
   E. Participated optimally in extra-instructional activity.
III. Social behaviors.
   A. Created a free or democratic atmosphere.
   B. Provided guidance, and maintained control of pupils.
   C. Evidenced satisfactory personal-social relations.
   D. Oriented new pupils effectively.
   E. Made effective use of parent contacts.
IV. Personal behaviors.
   A. Evidenced and applied knowledge of pupils and subject matter.
   B. Displayed satisfactory personal characteristics.

3. The critical behaviors reported as ineffective by pupils were capable of classification under the following common sub-areas:

I. Administrative behaviors.
   A. Failed to administer and organize the program adequately.
   B. Handled equipment and supplies improperly.
II. Instructional behaviors.
   A. Failed to instruct properly in physical education skills and activities.
   B. Failed to provide optimal instruction and activity in healthful living.
   C. Failed to participate properly in the instructional program.
   D. Evaluated the learning situation unreasonably.
   E. Failed to participate effectively in extra-instructional activity.
III. Social behaviors.
   A. Imposed an autocratic atmosphere.
   B. Failed to provide guidance for and control of pupils.
   C. Evidenced unsatisfactory personal-social relations.
   D. Failed to provide orientation for new pupils.
   E. Failed to employ discretion in parent contacts.

IV. Personal behaviors.
  A. Lacked knowledge of pupils and activities.
  B. Displayed unfavorable personal characteristics.

4. The outline of critical requirements, as determined from the educator reports, numbered 24 effective behavior classes, while there were 29 classes of an ineffective nature outlined in a similar manner.

5. Retaining the symbol structure of the pupil consensus outline, the effective critical behaviors reported by the educator group were classified as follows:

I. Administrative behaviors.
  A. Administered and organized the program adequately.
  B. Handled equipment and supplies efficiently.
II. Instructional behaviors.
  A. Provided effective instruction in physical education skills and activities.
  B. Offered capable instruction and activity in healthful living.
  C. Participated properly in the instructional program.
  D. Evaluated the learning situation fairly.
III. Social behaviors.
  B. Provided guidance, and maintained control of pupils.
  C. Evidenced satisfactory personal-social relations.

6. The ineffective critical behaviors reported by the educator group were classified as follows:

I. Administrative behaviors.
  A. Failed to administer and organize the program adequately.
II. Instructional behaviors.
  A. Failed to instruct properly in physical education skills and activities.
  B. Failed to provide optimal instruction and activity in healthful living.
  C. Failed to participate properly in the instructional program.
  D. Evaluated the learning situation unreasonably.
III. Social behaviors.
  B. Failed to provide guidance for and control of pupils.
  C. Evidenced unsatisfactory personal-social relations.
IV. Personal behaviors.
  A. Lacked knowledge of pupils and activities.
  B. Displayed unfavorable personal characteristics.

7. The most frequently reported *classes of behavior* (more specific than the *sub-areas* in the outlines above) furnished by pupils were 1. "demonstrated and corrected effectively skills and use of equipment and used repetition in practice;" 2. "conducted individual and/or small group instruction in skills;" and 3. "counseled individual pupils in difficulty." By way of comparison, the greatest number of educator-reported effective incidents concerned 1. "demonstrated and corrected in teaching skills;" 2. "organized squads, and delegated responsibility to leaders;" and 3. "explained well with repetition."

8. Highest frequencies of behaviors cited as ineffective by students were 1. "displayed favoritism in dealing with pupils;" 2. "punished—sometimes the innocent—unfairly and unreasonably;" and 3. "failed to take safety precautions (including constant presence)." Meanwhile, the ineffective behaviors reported most often by educators were 1. "failed to demonstrate

and explain activities properly;" and 2. "failed to maintain good class control."

Conclusions

The conclusions derived from the present study were as follows:

1. Apparently overt behavioral incidents are observable and may be classified and categorized.

2. From the data gathered in this study and with special attention to those behaviors most frequently reported, it may be surmised that, according to students, the effective physical educator should provide capable instruction in activities and maintain good control of pupils.

3. Similarly, conclusions drawn from the educator sample indicate that good teaching in physical education is most frequently characterized by effective instruction in skills and efficient program administration and organization.

4. The implication may be drawn from a study of student reports that the ineffective teacher of physical education fails to provide guidance and control and to establish satisfactory personal-social relations.

5. Likewise, educator observations inferred that poor teaching in physical education is evidenced primarily by failure in administration and instruction and by inadequate guidance and control.

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(Submitted 7/24/57)

Validating an Index of Social Adjustment for High School Use

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Abstract

Social adjustment and socialization by means of games, sports, and other physical education activities have always been objectives of physical education. This study represents an effort to develop and validate an instrument which will quantify the degree of social adjustment and screen out those students requiring special consideration and guidance. A *Behavior Trend Index* of 20 dichotomous behavior items and scale norms for the same are provided.

THE PLAYGROUND and gymnasium provide the careful observer with numerous examples of behavior indicative of the pupil's social feeling and adjustment. The processes by which an individual becomes a participant in his group, adjusts to it, and builds some semblance of social conduct and personality is of concern to the physicial education teacher. The search here is for means of quantitatively charting the student's degree of harmony with his social group and his social growth from year to year. This is important, not only for evaluating the degree to which we are attaining one of our educational objectives, but also for the understanding and guidance of individuals.

In thinking of a socially well-adjusted student, the following word picture may be considered as a criterion.

One who has a feeling of social security as the result of his social skills, his social "know how," and because he is accepted and "fits into the group." One who feels "at home in the group" and does not feel that he differs markedly from the ways the group feels are important. He has group status and is accepted by the group. One interested in the games, hobbies, and activities favored by the majority of his classmates.

Efforts to quantify degrees of social adjustment by "yes-no" paper and pencil responses by the very individuals we seek to study result in disingenuous responses unless the devices are carefully camouflaged. A higher degree of validity should result from the combined results of several competent observers who have dealt with the individuals in group situations and are asked to respond by making judgments to specific "ways of behaving" on the part of the subjects in these group situations.

---

[1]The author wishes to acknowledge the co-operation of following high school teachers in supplying data for recent validation efforts: Michael Bylene, Marion (Ind.), William Davis, Albion (Ind.), Michael Signorella, Ottawa (Ill.), Lyle Edenburn, Lizton (Ind.), and Frank Kurth, Hobart (Ind.).

Purpose

The purpose of this study was to further develop and validate an instrument that would discriminate and quantify the degrees of social adjustment in high school youth and to provide a tentative index scale for this purpose.

Origin and History of the Instrument

Since this problem originated some years ago and data gathered from time to time, a few brief comments are needed for clarification.

While studying the differentials which characterized junior high school boys who tended not to participate wholeheartedly in physical education (N = 50), versus those who participated freely (N = 50), the investigator cast about for behavior trend items which were related to good and poor social adjustment (1), From the work of Freyd (4), Marston (6), and Schwegler (7), certain behavior items were selected. These were paired dichotomous behavior descriptions representing good and poor adjustment. Teachers and special observers responded to these items with boys from the two criterion groups in mind, but unaware of the group membership of the individual or the purpose of the study. From this study resulted a number of behavior trends having highly significant critical ratios indicating a high index of discriminating power for selecting socially well and socially maladjusted boys in terms of the two criterion groups. Careful statistical purification of 39 behavior trends and their paired opposites checked by some 30 teachers resulted in selection of 12 paired behavior trends (a positive item and its corresponding negative opposite) with the highest discriminating index.

The reliability of the observers and the extent to which the negative behavior trend items were true opposites of the positive items was indicated by a permutation reliability coefficient of −.82, indicating that when observers said that a certain positive behavior trend was "markedly descriptive" of the subject, they tended to regard its negative opposite as "not at all descriptive" of a given subject (1, 2).

In order to test the hypothesis that the 12 pairs of behavior trends represent an "adjustment syndrome"—a group of symptoms occurring together—the correlations between the total resultant scores for each trend were calculated for the positive and negative angles. These tables were then subjected to factor analysis by the Thurstone Method. The ten behavior-trend pairs retained (Appendix A) indicated that a single factor seemed to account for the observed intercorrelations (2). The results of the correlation of each item with the general adjustment factor indicate that the behavior trends retained can be considered rather as common denominators underlying good or poor adjustment, according to sign (plus or minus). This internal consistency or internal validity of the instrument is important.

Further Validation Techniques

1. The Social Behavior Trends Indexes (Forms A and B)[2]*—Intercorrelations with the Social Adjustment Index.* Three different teachers were asked

[2]See Appendix, p. 13.

to check each student using Form A. These were collected and, at least a week later, they were asked to check the same students on Form B. Each student was checked by three teachers from the positive and then from the negative extreme at different times. Instead of two extremes, the observers had only *one* concept in mind at a time. A plus or minus score was found for every item in each trend pair. The total plus scores by the three observers and the total minus scores were added for each pupil, resulting in a differential "adjustment score." With each subject rated twice by each of three observers—once from positive and once from the negative angle—each subject was given the equivalent of *six* ratings. Kurth (5) gathered data on 50 Hobart, Indiana, junior high school boys. From these data one might ask, "Do students, who in the judgment of their teachers tend to exhibit the negative social-behavior-trends, also tend to be isolated and rejected by members of their own social group?" Intercorrelations in Table 1 tend to indicate that students not in good rapport with their associates might well be considered as somewhat socially maladjusted. This is indicated by positive correlation coefficients of .50 and .62 between the teachers' judgments as indicated by checking the Social Behavior Trend items and the judgment of the subjects' peers on the Personal Distance Scale and Who's Who Ballot, respectively. Other relationships are of interest, especially the high degree of positive relationship ($r = .84$) between the Personal Distance Ratings and the Who's Who Ballot.

2. The Personal Distance Score as an Indication of Social Adjustment. For diagnostic purposes, measurement of teachers' reactions to the social behavior of the pupils cannot be considered by itself alone. The teachers' judgments of social behavior are apt to be based on mature adult standards and to be indicative of the child's adjustment in dealing with adults in the classroom situation while the student employs the standards of his own group. A student's index on the Cowell Personal-Distance Scale (Appendix B) depends largely on his own degree of social participation in his own group and therefore on his own individual "social stimulus value."

In a study of the social integration of a college football squad, Trapp (10) found positive reliability coefficients of .91, .88, and .93 between balloting on the same boys by the same people at three different times during the football season.

One's degree of belonging to, or of being accepted as a member of one's own social group is surely an important criterion of his adjustment to that group. Perhaps it is important that both the norms set by the student group as well as the norms set for students by the teacher group be weighted in some fashion. A *mean* of the two combined percentile scores should give a pretty sound index of social adjustment, yet for diagnostic purposes each score should be retained separately.

3. The Who's Who Ballot (Appendix C) provides an additional valuable instrument to validate both the Personal-Distance Ballot and the Social Adjustment Index. These items were scored by counting the negative items -1

TABLE 1

Social Adjustment Ratings by Teachers with Other Test Items and Intercorrelations of Each Variable[1] with the Other Eleven

Variable[1]	1	2	3	4	5	6	7	8	9	10	11	12
1	—	.502	.628	.142	.419	.481	.253	.565	.029	.548	.430	.539
2		—	.844	.257	.187	.244	.357	.299	−.052	.705	.616	.900
3			—	.413	.254	.252	.340	.415	−.062	.800	.778	.781
4				—	−.054	−.161	−.000	.096	.196	.626	.706	.230
5					—	.515	.478	.502	.072	.329	.046	.272
6						—	.581	.702	.224	.216	−.062	.313
7							—	.462	.134	.368	.115	.346
8								—	.086	.551	.161	.405
9									—	.012	.059	−.002
10	2.58 = .369 (1% level of Confidence)									—	.753	.692
11	1.96 = .280 (5% level of Confidence)										—	.635
12												—

[1]The Variables:

1 Social Adjustment Rating by Teachers (Forms A & B)
2 Pupil Personal Distance Ballot
3 Pupil Who's Who Rating
4 Total Score: Chin-ups and Push-ups
5 New California Short-Term I.Q.
6 English Grades
7 Mathematics Grades
8 Health Grades
9 Shop Grades
10 Physical Education Grades
11 Game Skill Rating (Basketball)
12 Dean Guidance Office Rating

and the positive items +1 and totaled the times each boy's name was given. A student's total resultant score (plus or minus) was his *Who's Who* score. Table 1 indicates the significant relationships between judgments based on studies of the 50 freshman boys of Hobart, Indiana.

4. Further Validation Using the Biserial Correlation Technique. In order to test further the validity of Social Adjustment Index, three teachers were given in writing the verbal description of a socially well adjusted student which appears in the introduction of this article. These three teachers (two women, one man) were asked to think of each boy's behavior in *group* situations and write the names (in rank order) of the five *best* socially adjusted boys, and the five *worst* adjusted in terms of the definitions or "word picture" supplied. The results were gathered and sealed in an envelope. The selections were made from a total representing 48 seventh-grade boys in two Marion, Indiana, high school classes.

Two weeks later the name of each boy in the class was typed on a Form A (positive) of the Social Adjustment Index and each form checked for each boy by the three teachers. Two weeks later, Form B (negative) was similarly presented and checked by the same teachers. The differential scores (positive scores on Form A minus the negative on Form B) from each of the three teachers for each boy were then added and considered the Social Adjustment Index.

The boys were next ranked in the order of their indices according to the size of the positive scores. When this list was completed, the envelope containing the teachers' responses to the verbal word-picture description of good social adjustment was opened and those whose names were mentioned as "worst adjusted" underlined with red pencil and those mentioned as "best adjusted" underlined with blue pencil.

Hence, the distributions of those students originally considered "best" and "worst" adjusted by the teachers were available as well as the standard deviation of the Social Adjustment Index scores on the entire class. The fact that the mean of the Social Adjustment Index scores of those originally selected as "socially well adjusted" by teachers, was considerably higher than that for the "socially maladjusted" showed high validity in the Social Adjustment Index for this particular group when a biserial correlation was employed.

Visual inspection of the distribution of "red" (poor adjustment) and "blue" (good adjustment) on the ranked score lists of two other classes in different schools indicated a similar grouping of the two dichotomous adjustment scores.

A biserial correlation coefficient was computed for the two extreme tails of the distribution, i. e., "Best socially-adjusted boys" and "Worst socially-adjusted boys" (7). The value for r_{bis} was found to be +.824 and the standard error (r_{bis}) was .016. Under the assumption that the biserial correlation coefficient is zero, the value for r_{bis} obtained from the present data ap-

pears to be highly significant. Hence, it is unlikely that the teachers' prerating judgments of "best" and "worst" socially adjusted and the combined scores of Form A and B (Social Behavior Trend Index) were distributed as chance variables.

Athletic Participation and Social Adjustment

Though not a direct validation of *The Social Behavior Trend Index*, some other relationships are of interest. In a study of a random sampling of 25 senior boys in an Illinois high school (9) with a senior class of 152 boys and girls, the following correlation coefficients resulted:

Social Adjustment Index score and Degree of Athletic Participation +.424
Degree of Athletic Participation and Academic Rank in Class +.280
Social Adjustment Index score and Academic Rank in Class +.233

Ascribing some validity to the Social Adjustment Index, a moderate positive relationship existed between social adjustment and athletic participation among the senior boys of this school.

The assumption that high I. Q. and low class academic rank is evidence of poor social adjustment was not studied statistically but positive trends seemed evident. This should be studied in the interest of guidance.

Norms

A norm is an experimentally derived index which enables teachers to compare the achievements or status of their students with those of a similar age and grade. For purposes of further trial of the instruments suggested, percentile scales are supplied for both the Social Adjustment Index (Appendix D) and the Personal Distance Scale (Appendix E). Although these norms are based on junior high school boys from five different cities, some past use of fairly similar scales with girls and with older boys (1, 2) leads the investigator to believe that thorough experimentation will find them significantly valid for use with these groups as well.

Conclusion

The instruments described indicate that selected groups of boys who were poorly adjusted socially made significantly different scores from boys in general.

Recommendation

For purposes of evaluating social growth and group status, and for sensitizing teachers to the guidance needs of students at the lower end of the adjustment and acceptance scales, the instruments here presented provide means for quantifying these by scale scores.

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APPENDIX A

Cowell Social Behavior Trend Index (Form A)

Date: ____________ Grade: ________

School: ____________ Age: ________

____
Last Name First Name Describer: ________________

INSTRUCTION:—Think carefully of the student's behavior in group situations and check *each behavior trend* according to its degree of descriptiveness.

Behavior Trends	Descriptive of the Student: Markedly (+3)	Somewhat (+2)	Only Slightly (+1)	Not at All (+0)
1. Enters heartily and with enjoyment into the spirit of social intercourse				
2. Frank; talkative and sociable, does not stand on ceremony				
3. Self-confident and self-reliant, tends to take success for granted, strong initiative, prefers to lead				
4. Quick and decisive in movement, pronounced or excessive energy output				
5. Prefers group activities, work or play; not easily satisfied with individual projects				
6. Adaptable to new situations, makes adjustments readily, welcomes change				
7. Is self-composed, seldom shows signs of embarrassment				

(*Continued on next page*)

Behavior Trends	Descriptive of the Student: Markedly (+3)	Somewhat (+2)	Only Slightly (+1)	Not at All (+0)
8. Tends to elation of spirits, seldom gloomy or moody				
9. Seeks a broad range of friendships, not selective or exclusive in games and the like				
10. Hearty and cordial, even to strangers, forms acquaintanceships very easily				

Cowell Social Behavior Trend Index (Form B)

Date: ______ Grade: ______

School: ______ Age: ______

Last Name First Name Describer: ______

INSTRUCTION:—Think carefully of the student's behavior in group situations and check *each behavior trend* according to its degree of descriptiveness.

Behavior Trends	Descriptive of the Student: Markedly (—3)	Somewhat (—2)	Only Slightly (—1)	Not at All (—0)
1. Somewhat prudish, awkward, easily embarrassed in his social contacts				
2. Secretive, seclusive, not inclined to talk unless spoken to				
3. Lacking in self-confidence and initiative, a follower				
4. Slow in movement, deliberative or perhaps indecisive. Energy output moderate or deficient				
5. Prefers to work and play alone, trends to avoid group activities				
6. Shrinks from making new adjustments, prefers the habitual to the stress of reorganization required by the new				
7. Is self-conscious, easily embarrassed, timid or "bashful"				
8. Tends to depression, frequently gloomy or moody				
9. Shows preference for a narrow range of intimate friends and tends to exclude others from his association				
10. Reserved and distant except to intimate friends, does not form acquaintanceships readily				

APPENDIX B

Cowell Personal Distance Ballot

What To Do:	I would be willing to accept him:						
If you had full power to treat each student on this list as you feel, just how would you consider him? How near would you like to have him to your family? Check each student in *one* column as to your feeling toward him. Circle your own name.	Into my family as a brother 1	As a very close "pal" or "chum" 2	As a member of my "gang" or club 3	On my street as a "nextdoor neighbor" 4	Into my class at school 5	Into my school 6	Into my city 7
1.							
2.							
3.							
4. etc.							

NOTE: The Personal Distance Score is determined by adding the total *weighted* scores given the subject by members of the class or group and dividing by the total number of respondents. Division is carried to two places and the decimal point dropped. The low score is the desirable score. The percentile scale scores in the appendix represent boys' attitudes toward accepting boys. It is possible also to determine girls' attitudes toward girls, boys' attitudes toward girls and vice-versa by various methods of balloting.

APPENDIX C

Who's Who in My Group[1]

1. There are some boys who are very poor at playing games. When it is time to choose sides for a game they are almost the last ones chosen. You wouldn't want to have these boys on your team. Sometimes they try hard, but they just can't play well. Who are some boys on the list like this?
2. Are there any boys in this group who are very good in the games we play? They seem to be the best players. Everyone wants to choose them first because they are good boys to have on the team. Who are these boys?
3. Some boys always seem to feel at home wherever they are. They are not afraid to say what they think in class discussions. They ask questions if they don't understand something. They don't mind meeting strangers and can talk easily with grown people and older boys. Who are some boys on the list that almost never seem shy or bashful?
4. Are there any boys in this group who are too bashful? Are there some who are very shy and almost too quiet? These boys often want to be alone or just with one friend. They almost never enter into class discussions. They almost never ask questions. They don't want to be noticed very much. They prefer to stay in the background. Who are they?
5. Suppose you were going to choose people from this group to be on your committee. You want boys who will work well with others, who have good ideas, who work hard, and who stick to the job until it is finished. They know how to play and do good work. Who would you select in this group?
6. Some boys are no good to have on a committee. They don't get along with the others. They don't work very hard. They don't stick to the job. They don't share the work. They never seem to have any good ideas for the committee. Do we have any boys on our list like this? Who are they?

APPENDIX D

Percentile Scale—Cowell Social Adjustment Index

Score Raw	%ile Score	Raw Score	%ile Score	Raw Score	%ile Score
88	99.55	60	90.09	43	73.42
81	99.10	59	89.19	42	72.97
80	98.65	58	88.29	41	72.52
79	98.20	57	86.49	40	72.07
78	97.75	56	86.04	38	71.17
77	97.30	55	85.14	37	69.37
75	96.85	54	84.23	36	68.47
74	96.40	52	83.33	35	67.12
73	95.94	51	82.88	34	65.32
72	95.50	50	82.43	33	64.41
70	95.04	49	81.08	32	63.51
68	94.59	48	80.18	31	61.26
65	92.79	47	79.28	30	59.91
63	92.34	46	78.38	29	59.01
62	91.44	45	77.03	28	57.21
61	90.54	44	74.77	27	56.31

(*Continued on next page*)

[1]Adapted from The Ohio Acceptance Scale, 1948, by permission of the Ohio Scholarship Tests, State Department of Education, Columbus, Ohio.

Raw Score	%ile Score	Raw Score	%ile Score	Raw Score	%ile Score
26	55.40	2	32.43	−28	12.16
25	54.95	1	30.63	−29	11.71
24	53.60	−1	29.73	−35	10.81
23	52.70	−2	28.38	−36	9.91
22	51.80	−3	27.48	−39	8.56
21	50.90	−5	26.00	−40	8.11
20	50.45	−6	25.22	−42	7.66
18	48.65	−7	23.87	−43	7.21
17	46.85	−8	23.42	−44	6.76
16	45.94	−9	22.97	−45	6.31
15	45.50	−12	22.52	−46	5.40
14	45.04	−15	21.62	−47	4.50
13	43.24	−16	21.17	−49	4.05
12	41.44	−17	20.72	−50	3.60
11	40.54	−18	19.82	−54	3.15
10	40.09	−19	18.92	−55	2.70
9	38.74	−20	18.47	−58	1.80
8	37.84	−21	17.51	−61	1.35
7	36.94	−23	16.22	−62	.90
6	35.59	−25	15.32	−71	.45
4	34.68	−26	13.96	−73	.00
3	33.33	−27	12.36		

n = 222

APPENDIX E

Percentile Scale—Cowell Personal Distance

Raw Score	%ile Score	Raw Score	%ile Score	Raw Score	%ile Score
159	99.34	260	82.78	319	62.91
161	98.68	265	82.12	321	61.59
173	98.01	266	81.46	327	60.93
196	97.35	267	80.79	329	60.26
200	96.69	271	79.47	331	59.60
205	94.04	274	78.81	333	58.94
210	93.38	281	76.16	335	57.62
211	92.71	282	75.50	336	56.29
219	92.05	283	74.17	344	54.97
220	91.39	284	73.51	347	54.30
222	90.73	285	72.85	351	53.64
233	90.07	289	72.18	352	52.98
237	89.40	294	70.20	369	45.70
240	88.74	295	68.87	371	45.03
252	88.08	300	68.21	375	44.37
256	86.75	311	65.56	376	43.71
257	84.10	312	64.90	377	43.05
259	83.44	315	64.24	378	41.06

(Continued on next page)

Raw Score	%ile Score	Raw Score	%ile Score	Raw Score	%ile Score
379	40.40	395	31.79	431	13.91
353	51.66	396	31.12	433	13.24
354	50.33	398	30.46	434	12.58
355	49.67	400	29.80	435	11.92
357	49.01	405	26.49	439	11.25
359	48.34	412	25.83	445	10.60
361	47.68	415	25.16	455	9.93
363	47.02	416	24.50	457	9.27
366	46.36	417	23.84	469	7.95
380	39.74	418	23.18	470	7.28
381	38.41	419	21.19	471	6.62
382	37.75	420	20.53	482	5.96
384	37.09	421	19.87	495	5.30
385	36.76	422	19.20	496	4.64
386	35.10	423	17.22	500	3.97
389	34.44	425	16.56	503	1.99
390	33.77	426	15.89	509	1.32
391	33.11	428	15.23	541	.66
392	32.45	429	14.57	636	.00

n = 151

(Submitted 7/31/57)

Depression of Muscle Fatigue Curves by Heat and Cold[1]

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Abstract

Immersion of the forearm in hot water (48° C for 8 min.) did not affect initial strength or steady-state "fatigue level," but did cause a 34 per cent increase in the rapidity of fatigue. Substitution of cold water (10° C) decreased initial strength 11 per cent without altering the observed fatigue level. Because of less work per contraction, fatigue was considerably less than under control conditions. Massage was without effect. Using a spring-loaded ergograph, the fatigue curve showed an exponential drop-off in work output, and was accurately described by a simple mathematical formula.

IN RECENT years several studies have been undertaken to determine the effects of various preliminary conditions such as warm-up and massage on physical performance, the period of recovery, and the gross energy cost. Other studies related to this general area have been conducted on the application of cold in the form of a water spray or ice packs to individuals immediately before work performance.

Review of Literature

Effects of Heat. Asmussen and Boje (1) observed that passive heating by radio diathermy or by hot showers had a beneficial effect on physical performance that was proportional to the temperature involved. The results on four subjects indicated that diathermy improved performance on a bicycle ergometer 3.9 to 7.6 per cent and hot showers improved performance 5.0 to 7.2 per cent. The increase in performance was attributed to an increase in temperature of the local muscles.

Muido (8) arrived at similar conclusions when he studied the influence of body temperatures on swimming performance. Hot showers improved swimming times by 2.1 to 3.9 per cent and diathermy improved the times 1.3 to 1.9 per cent. Muido felt that the improvement in time was due to an increase in blood temperature, instead of the local muscle temperature as contended by Asmussen and Boje.

Carlisle (2) found that hot showers used as a preliminary passive warm-up increased the performance of swimmers. Ten swimmers in 230 trials showed an improvement of 1 per cent in the 40-yard swim when the trials were preceded by an eight-minute hot shower. The difference between the control and the pre-heated trials was significant. Carlisle found that per-

[1] From the Research Laboratories of the Department of Physical Education. The writer is indebted to Dr. Franklin Henry for advice and encouragement, and for designing the apparatus.

formance was not closely related to rectal temperature and points out that muscle temperature is known to vary independently of rectal temperature.

Robins (11) stated that strength, as measured by a hand dynamometer, decreased following a hot shower. The difference between the control and the experimental condition was statistically significant.

Nukada (9) studied the effects of heat upon the upper arm when the arm held a 5 kg. weight with the elbow at a 90° angle and the forearm in a horizontal position. The upper arm was heated by two methods—diathermy and hot water. An increase in the temperature produced a decrease in the time that the arm could maintain the ninety degree position. This effect was attributed to the shift of blood from the muscles to the skin.

Effects of Cold. Happ et al (4), concentrating upon the physiological responses in recovery from fatigue, concluded that recovery is facilitated by the application of abdominal ice packs. In 11 subjects, the loss in work output in the second of two closely spaced work periods was reduced when ice packs were applied to the abdomen of the subject during the rest phase between the work periods. However, there was an increase rather than a decrease in the work output of the second trial in some of the cases.

Rosen (12) suggested that the effects of the application of cold might depend upon the individual. He found that some runners in the 440-yard run could improve their times significantly with the application of cold, while other runners exhibited slower times.

Robbins, in the study previously reviewed, found that there was no significant change in grip strength following a cold shower.

Muido (along with the effects of hot showers mentioned above) found that cold showers had a detrimental effect of 3.6 to 6.3 per cent on swimming times.

Sills and O'Riley (13), who investigated the effects of the application of cold to the abdominal region on spot-running, found that physical performance (number of steps) was improved more by the cold application than by either preliminary rest or exercise.

Nukada and Muller (10) investigated all-out performance on two subjects, one trained and the other untrained, using a weight-loaded foot ergometer with the whole leg immersed in water. The temperature of the water was varied of 10° to 40° centigrade. One of their conclusions was that the colder the skin temperature, the longer an all-out performance (for the same work-load) could be maintained. If the leg was immersed in cold water and then taken out, the performance level was decreased. The reduction was attributed to hypermia of the skin.

Effects of Massage. Asmussen and Boje (1) stated that massage had little or no effect on performance. This statement was based upon results on two subjects, one of whom showed improvement in both of two tests while the other showed improvement in one test and no change in the other.

Hale (3) reported that there was no significant influence of massage on the performance of the 440-yard run. His seven subjects showed improvement scores as follows (in seconds: 0.9, -0.1, 1.0, 0.6, 0.7, 1.1, and 0.4. The t-ratio for these differences is 4.24, which is significant, although he states in another article that it is 0.48 (7). The discrepancy has resulted from his computation of the standard error of the mean by the method for independent groups when he should have used the formula for differences within the same individuals.

Comment. A majority of the investigations have used total body performances, i.e., 440-yard run, swimming, bicycle ergometer, etc., to determine the effect of heating the body prior to exercise. The results of these studies tend to agree in showing that "passive warm-up" by the application of heat improves performance, although it must be pointed out that heat had a deleterious effect on local muscle endurance in one set of experiments (9).

In the case of cold, those experimenters who had their subjects engaged in a period of vigorous exercise prior to a cold shower or other application, seem to have found beneficial effects. Muido, who only applied cold prior to performance, found a deleterious effect, and Robbins found no change in local muscle strength.

Massage presents a curious situation. Evidently, the experimenters who have worked with this treatment under controlled conditions were thoroughly convinced that it had no effect. However, their data, considered factually, present as favorable a case for a beneficial effect of massage as has been shown for other treatments. A careful reading of the Asmussen and Boje report, for example, shows that they have accepted their evidence for an improvement in muscle strength from warm-up, while failing to accept the same type of evidence for an improvement owing to massage. The Hale data and conclusions were discussed earlier.

The present study is concerned with investigating the possible effects of heat, cold, and massage on strength and fatiguability of voluntary muscle contraction in the human subject. It is limited to local effects, at least in terms of application of the treatment, and no specific attempt will be made to evaluate any whole body effects.

Methodology

APPARATUS

Recording Device. An important consideration was the need for a continuous record that would permit an analysis of the force of each individual contraction. There was available in the laboratory a modified Smedley dynamometer originally designed for pneumatic recording. The action of the instrument was connected mechanically by a flexible 25-inch cable to the writing lever of a moving paper recorder. The lever was adjusted to a magnification of 8-fold, which gave 1.22 cm. movement on the paper for 10 kg. of force exerted on the dynamometer. At the end of the writing lever was

a celluloid ink pen of the conical well type, orginally used on a Tycos recording sphygmomanometer. The pen and lever system was very light (see Figure 1).

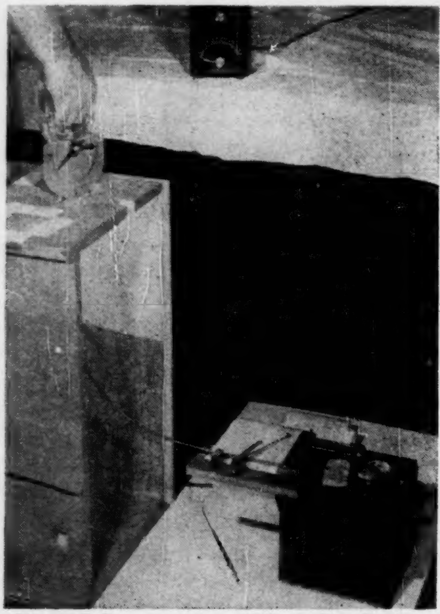

FIGURE I. Dynamometer and Recording Device.
(During use, the dynamometer dial does not touch the storage support.)

The paper drive was a modified Correll constant-speed electric kymograph equipped with a small rubber-covered drive roller approximately 2 inches in diameter, operating horizontally. The paper was ordinary 5-inch adding machine tape, moving at 5 inches per minute.

The instrument, therefore, constituted a spring-loaded ergograph with direct ink recording, and yielded a fatigue curve of maximal work by the forearm muscles. Successive contractions were made at intervals of 2 seconds (nominal), the cadence being established by a flashing-light plus sound electric metronome.

Arm Immersion Tank. A whirlpool bath with the agitator disconnected was used for both hot and cold water treatments. The constant temperature thermostat of the tank was used to control the temperature of the hot water, being checked periodically with a laboratory thermometer. For the cold water treatment, a mixture of ice water and tap water was used to establish and maintain the desired low temperature. The whirlpool bath was adjacent to the ergograph so that transition from immersion to test conditions could be made within a constant interval of 30 seconds.

SUBJECTS

The 12 subjects were males from physical education classes and junior members of the staff at the University of California. Their ages ranged from 18 to 34 years.

EXPERIMENTAL DESIGN AND TREATMENT

The investigation consisted of four test periods. The 12 subjects were arbitrarily divided into four sub-groups of three men. Each sub-group started with a different one of the four conditions and then rotated systematically through the other three in this order: control, heat, cold, massage. The total number of tests, therefore, constituted a balanced series. The time each subject performed the test was determined by the subject's daily activity. An attempt was made to keep the two-hour period before the test similar for all four tests. There was a lapse of seven days between successive test administrations, in order to permit recovery from the maximal muscular exertions. The position of the apparatus and the subjects was constant during the investigation. The subjects were unable to see their recordings during performance. External conditions such as room temperature, noise level, and other distracting influences were standardized as far as possible.

The temperature of the water during the heated immersion period (48° C) was selected on the basis of preliminary experiments that indicated that this was the maximum that could be tolerated without undue pain or movement indicating excessive discomfort during the period of adaptation.

The temperature of the cold immersion treatment (10° C) was chosen on a similar basis. It was desired to use as wide a temperature variation as practical, in order to secure the greatest possible experimental effects.

The duration of the eight-minute immersion was based on the times used in several other investigations, notably Carlisle (2). The length and type of the massage was determined by observations of procedures that were commonly used in the training quarters of the University of California. The investigator administered the massage on all subjects, so that there was some standardization of the degree of massage.

TEST PROCEDURE

Each test period was divided into two parts; the preliminary, in which the experimental treatment of the arm was applied, and the period of physical performance (i.e., the work period). There was a constant interval of 30 seconds between each part of the test period.

Preliminary or Treatment Period. In rotation, one or the other of the following treatments were given just before the work:

(a) Control: There was an eight-minute rest period before the performance of the work period. During the rest period, the subject was asked to sit in a comfortable manner and "take it easy."

(b) Heat: An eight-minute period when the arm was immersed in water at a temperature of 48° C. The forearm rested upon the bottom of the bath, while the subject sat in a chair, with the water level four inches above the elbow. The subject was informed that he should not make any unnecessary movements while the arm was immersed. At the end of the period, the subject was given a towel to wipe off water from his arm and hand.

(c) Cold: An eight-minute period in which the arm was immersed in water at a temperature of 10°C. Except for the temperature of the water, all other conditions were kept constant with the heated conditions.

(d) Massage: A four-minute period in which there was given a moderate massage to the muscles of the forearm. The term "moderate" is a subjective definition of the intensity of the massage given, which cannot be expressed in quantitative units.

Work period. The work period on the ergometer lasted for six minutes. During this period, the subjects were asked to produce a maximal contraction on each beat of the metronome. Throughout the work, the subject was constantly reminded to grip as hard as he could, in each contraction.

The subject made 180 contractions under each of the four conditions. In order to reduce the amount of time involved in the measurement of the records, only contractions number 2, 15, 30, 45, 60, etc. were actually worked up—in other words, the data used consisted of samples made at 13 places during the 180 contractions. Each of these samples was the graphic average (made by inspection) of the designated contraction and the contraction that just preceded and just followed it. Thus, the data for each subject represented a sample of 21.7 per cent of the contractions actually made. Since the mean values designated "total work" in Table 1 were computed

TABLE 1

Means and Differences in Work Under Various Conditions

Statistic		Control	Heat	Cold	Massage
Total Work (kgM)	m	2.965	2.794	2.602	2.963
Work Sample	m	2.2109	2.0844	1.9205	2.2098
	σ	0.4798	0.5254	0.4438	0.4227
Diff. from control	m_d	—	0.1265	0.2904	0.0011
Diff./σ_d	t	—	2.96#	3.25*	0.020
Correlation with control	r	—	0.964*	0.798*	0.821*

#Significant at the 2% level of confidence.
*Significant at the 1% level of confidence.

from the smooth curves in Figure II, they do not represent direct measurements as do the "work sample" data. All statistical evaluations of total work used the sample of directly measured contractions. Initial and final strength were measured at contractions 2 and 180.

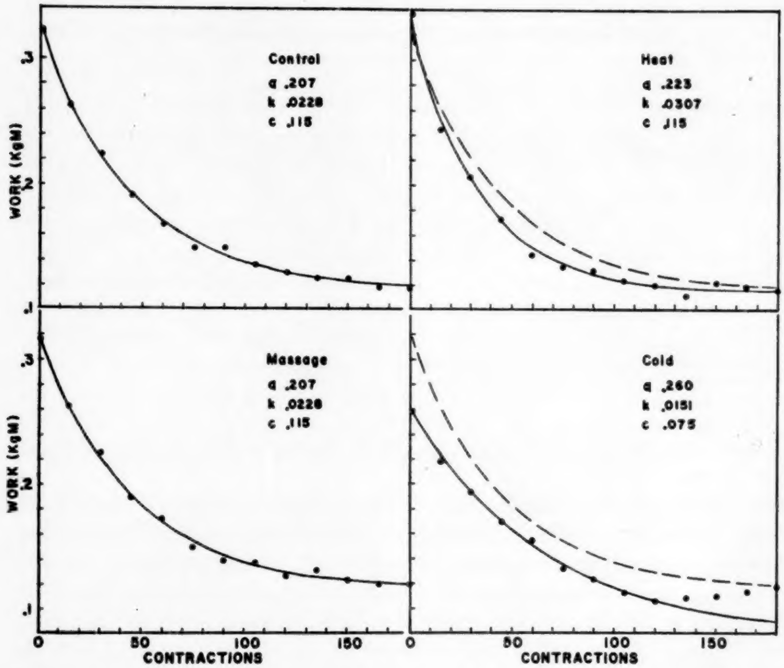

FIGURE II. Experimental Determinations of Fatigue following Four Pre-exercise Conditions.
(The dashed line in the graphs to the right is the fatigue curve for control conditions.)

Experimental Results

HEAT

Total Work. The effect of heat is contrary to expectation, with respect to most of the studies reviewed in the introduction. There is a substantial and statistically significant reduction in the amount of work accomplished, as a result of local application of heat. Compared with the control condition, the work output has decreased 5.8 per cent (see Table 1).

Initial Strength. Even though there is a slightly higher magnitude for initial strength under the heated condition, the difference from the control is not statistically significant (see Table 2). Two-thirds of the subjects are higher and one-third are lower, suggesting that even with a larger number of subjects the difference would remain non-significant.

Moreover, it is not a situation of irregularity of individual responses. This is shown by the fact that there is a correlation of 0.861 between control and heat responses, which did not differ significantly in mean results as explained above. In contrast, the correlation between control and cold con-

TABLE 2

Initial Strength and Final Strength under Various Conditions

Statistic		Control	Heat	Cold	Massage
Initial Strength (kg)	m	46.767	47.892	41.725	46.334
	σ	4.864	4.352	6.710	4.730
Diff. from Control	m_d	—	-1.125	5.042	0.433
Diff./σ_d	t	—	1.51	3.30*	0.36
Correlation with Control	r	—	0.861*	0.659#	0.655#
Final Strength (kg)	m	27.667	27.384	27.959	28.250
	σ	5.554	7.143	4.922	4.837
Diff. from Control	m	—	0.283	-0.292	-0.583
Diff./σ_d	t	—	0.24	0.26	1.42
Correlation with Control	r	—	0.838*	0.754*	0.600#

#Significant at the 5% level of confidence.
*Significant at the 1% level of confidence.

dition responses is only 0.659, although in this case the difference is highly significant.

Final Strength. Here again, there is no significant difference between the control and heat conditions (Table 2). This finding suggests that the lowered work output resulting from the application of heat causes more rapid fatigue of the muscles, and this is actually the case, as shown in Figure II. While the initial strength and final strength is the same for both conditions, the response of the heated muscle drops off rapidly as compared with the control.

COLD

Total Work. Local application of cold prior to exercise produces a relatively large (12.2%) and highly significant reduction in the work output as shown in Table 1.

Initial Strength. Eleven of the 12 subjects show a depression in initial strength as a result of the cold application, and the individual exception shows lower performance during most of the work period, even though his strength is higher for the first few contractions. On the average, the depression is 10.8 per cent, and in view of the high consistency of the depression, this mean difference is highly significant (see Table 2).

Final Strength. The depression in initial strength does not persist throughout the fatigue curve. By the end of the experiment, there has in fact been a slight rise (1.0%) in the strength of contraction as compared with the control conditions. However, this difference is not statistically significant (Table 2).

MASSAGE

There is no significant influence of massage on total work output, initial strength, or final strength. The fatigue curves (Figure II) are identical. In

view of these results, it seems fairly certain that local massage of the type used, administered prior to exercise, does not influence performance.

FATIGUE CURVES

Theoretical Considerations. Many types of biological functions and physical performances follow an exponential form of mathematical law (5). The fatigue curve of running follows this pattern (6); so does the fatigue curve of turning a bicycle crank as rapidly as possible (14).

The essence of the exponential law is that the decrease in work output in any given contraction, as compared with the contraction that immediately preceded it (measured as the amount above the "fatigue level") will always be a constant proportion of that contraction. For example, if the first contraction involved 1.0 kgM of work and there was a 10 per cent reduction of each contraction, the second would be 0.9 kgM; the third would be 0.81, the fourth 0.73; and the fifth 0.66; and so on. Following this progression, the 23rd contraction would be 0.10 kgM, and the mathematical expression describing the work for any particular contraction a_n will be

$$a_n = a_o e^{-k_{n'}} + C$$

where a_o is the work of the first contraction (above the fatigue level), C is the fatigue level, e is the Naperian log base, k is the rate constant and n′ is equal to n-l where n is the consecutive number of the contraction. The numerical value of k is computed from the relationship

$$k = \frac{2.303}{n'_{10}}$$

where n'_{10} is the number of contractions (less one) required for fatigue to progress from a_o (the work for the initial contraction) to a tenth of this amount of work (again, considering only the amount of work above the fatigue level or asymptote). The figure 2.303 derives from the fact that $e^{-2.303} = 1/10$.

As applied to the fatigue problem, the exponential theory assumes that each contraction uses up a certain fraction of the initial work potential of the muscle, over and above that of the steady state which maintains the fatigue level (5). This fraction will obviously be different if the rate of contraction is increased or decreased. The loss in work potential as between the first and second contraction, for example, represents an algebraic balance between the amount of energy used for the contraction and the amount functionally restored during the partial recovery that occurs between the two contractions.

The fatigue level is mathematically an asymptote. The theory assumes that this asymptote will be approached in a systematic and progressive manner, other things being equal. Change in motivation, for example, will cause irregularities in the curve. Also changes in physiological conditions will cause departures from the simple exponential formula.

Application to Experimental Conditions. The exponential curve has been fitted to the control data by inspection (5), resulting in the curve constants shown in Figure II. The standard deviation of the residuals from this fitted curve is 0.0032 kgM, a value which is small in comparison with the overall variation among the observed values, suggesting that the fit is very good. The correlation between the 13 observed points and the values computed from the formula is 0.998.

These same constants that were used for the control have been used to draw the massage curve in Figure II. The standard deviation of the residuals from this curve is also very low, 0.0033 kgM, the correlation between the curve and experimental points being 0.998. Evidently, there has been no effect on the fatigue curve as a result of the massage.

In the case of the fatigue curve for the heat condition, the curve constants for the control do not fit the points, as shown visually by the dash-line curve. The work done in the first contraction ($C + a_0$) is the same as under the control conditions, the fatigue level C is the same, and a_0 is the same. It is necessary, however, to use a velocity constant k that is 35 per cent faster, in order to secure the close fitting curve shown by the solid line. The standard error for this curve is quite small, 0.0047 kgM, although it is slightly larger than the fitting error for the two previous conditions. Relative to the over-all variation among the observed points, however, the fit is just as good, as indicated by the correlation between the observed and fitted points of 0.998. Evidently, the influence of the heat treatment is to increase the rate of fatigue, and thus decrease the amount of total work, without reducing either the initial strength or the fatigue level. At present, there does not seem to be any satisfactory physiological explanation for this result.

In contrast to the other conditions, the initial strength following cold application is depressed, the amount of work being 19 per cent lower on the first contraction. The work per contraction at the theoretical fatigue level C is lowered 35 per cent. However, the trend toward this fatigue level is reversed after 120 contractions, possibly due to warming of the muscles by exercise, and the final contraction (number 180) is 35 per cent higher than it would have been if the downward trend had continued. The work done in the final contraction is almost identical with the corresponding control condition, being actually 1.2 per cent higher. The rate of development of fatigue, as expressed by its velocity constant k, is 34 per cent slower than the control. The fit of the curve, up to the point of appearance of the warming phenomenon, is almost perfect—the standard deviation of the discrepancies is 0.0022 kgM, and the correlation between observed and calculated points is 0.999, up to contraction 120.

The warming effect was observed directly during the collection of data, prior to any measurement of the tape records or analysis of the results. It

had been anticipated that in the chilled arm, the active muscles would warm up faster than the inactive tissues, owing to local metabolic production of heat and perhaps increased local circulation. No thermocouple equipment was available, but it was readily noticed by simply "feeling" the skin over the different parts of the forearm immediately after exercise, that the areas over the active muscles were definitely warming up faster than other parts of the arm. These observations were made on all subjects, and seemed to be present in all cases. They are not offered as conclusive evidence. However, the effect was so marked that the experimeter has no doubt concerning its reality.

If it is assumed that the chilling of the arm has simply reduced the maximal contractility of the muscle (either directly or through the neuro-muscular junctions), the energy stores of the muscle would be depleted more slowly and acid metabolite production would be less per contraction, since each contraction is small compared with the control conditions. The relative reduction in strength and work for each succeeding contraction after the first would be less than in the case of control, and the curve constant k would be smaller, causing a flatter fatigue curve, as observed. Another factor would be considered is the warming-up effect. If this factor operates to restore contractability, it might well have produced a gradually increasing tendency towards relatively stronger contractions even before the effect is noted on the graph. This tendency would have the effect of flattening the fatigue curve and thus decreasing the size of the k. The curve as obtained has probably been influenced by both of these factors.

Discussion

The application of heat to local muscle groups was observed to have a detrimental influence on work output in the present study. This agrees with the results of Nukada (9) and Nukada and Muller (10), who found that local heat treatment caused a decline in the length of time that a muscle group could maintain a standard tension or a standard work output. It disagrees with the results of Asmussen and Boje (1), who found that local application of diathermy increased the work output on a bicycle ergometer. All of these studies used very few subjects, without crucial statistical evaluation in support of their conclusions.

It may be noted that Asmussen and Boje were of the opinion that the mechanism of the favorable effect of general body heating and preliminary exercise on physical performance was increased temperature of the local working muscles, which accelerates biochemical reactions and reduces muscle viscosity. Since the present experiment used only a single and rather high temperature external heat application, there is a possibility that a milder temperature would have a favorable influence. On the other hand, the Asmussen and Boje explanation, if it is theoretically valid, should apply to the experiment as performed.

Nukada, using maintenance of a standard submaximal tension, and also Nukada and Muller using maintenance of submaximal work output, found local application of cold to the muscles was beneficial. There was no statistical evaluation. In the present study, using maximal tension and maximal rate of work, there was definitely a decrement until the muscles warmed up near the end of the work period. The results do not exclude the possibility that application of cold to the abdomen (4) or to the whole body by cold showers (13) will improve performance through circulatory mechanisms.

Conclusions

Since the applications of heat and cold represented relatively extreme conditions without intermediate points, and the durations of treatment were arbitrary, wide generalization is not possible. The conclusion, therefore, must be interpreted as stemming from the use of specific experimental conditions, namely eight-minute application of a water bath at 10° or 48° C, or a four-minute local massage, followed by six minutes of work by the forearm muscles at the rate of 30 maximal contractions per minute, with observations of local rather than general fatigue.

The normal muscle fatigue curve, as observed with a spring-loaded ergograph shows a simple exponential decay. The work done by any particular contraction, n, is given by the expression $C + a_0e^{-k(n-1)}$ where a_0 is the work done in the first contraction, k is the fatigue rate constant, and C is the fatigue level. Pre-exercise massage does not influence the fatigue curve in any manner.

The local application of heat by immersion for eight minutes in water of 48° C, does not significantly change the initial strength or the fatigue level of a typical human muscle group. It does, however, increase the rate of fatigue k and thereby reduce the total work output of the muscle.

The application of cold reduces the initial strength, and decreases the amount of work that the muscle can do during the first few minutes of exercise. Following this period, the fatigue level strength rises to the normal value. The rate of fatigue k is slower in the cold muscle. It is inferred that this is caused by the smaller amount of work done by each contraction, as compared with the untreated muscle.

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(Submitted 7/25/57)

Learning To Juggle: III. A Study of Performance by Two Different Age Groups

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Abstract

Two groups of high-school freshmen boys learned to juggle. One group practiced five minutes daily, the other 15 minutes every other day. One minute of practice in the shorter sessions was worth 1.78 minutes in the longer. Significance of the difference between means was at the 1 per cent level of confidence. Results were compared with those of a similar study with college subjects. No significant differences between the means of comparable groups were found, neither of the values reached the 5 per cent level of confidence.

IN A PREVIOUS study of juggling (3) it was found that a short work-rest practice situation (five minutes per day) facilitated more rapid learning than a longer work-rest practice situation (15 minutes every other day). The subjects of that investigation were male seniors at the University of Illinois who were majoring or minoring in physical education. Since these subjects were highly selected and had the maturity and ability needed for performing complex sensory-motor skills, the findings should not be applied indiscriminately to other groups. The present investigation was designed to determine whether similar results might be obtained by using unselected relatively immature high school subjects in a similar learning condition.

Any attempt to predict relative levels of motor performance of unselected high school and college seniors specializing in physical education would almost certainly point to superiority of the college student. The statement "boys continue to improve in physical skills at least through the seventeenth year" (1, *p. 331*) is representative of what the literature says on this subject. Espenschade's study (2) shows almost continual improvement in athletic performance during the adolescent years. Out of curiosity, several colleagues of the writers were queried and without exception they predicted that the college students would learn to juggle more rapidly than the high school subjects.

Procedure

In the present study, the subjects were boys enrolled in physical education classes at Evanston Township High School. Selection of subjects was

at random. Practice preparations and instructions duplicated those in the previous study. The criterion for learning—100 consecutive catches—was the same. Several demonstrations of juggling were presented, mimeographed rules and suggestions were given to each subject, and discussion was permitted for the purpose of clarifying understanding of procedure. The rules and suggestions, identical with those given the college seniors, were:

A. Rules

1. Only the whole method is permissible.
   a. You may not practice the hand movements without using balls.
   b. You may not practice the toss and catch using less than three balls.
2. During a juggle at least one ball must be in the air at all times. If two balls touch a hand simultaneously the count must stop.
3. Time and distribution of practice session, as stipulated for your group, must be followed exactly.

B. Suggestions

1. Start with two balls in the dominant hand.
2. Toss and catch balls with rhythmical movements.
3. In tossing let the ball leave the hand approximately in front of the chin with the head facing forward.
4. Toss the ball to a height approximately equal to the top of your head.
5. Toss the ball so that it may be caught about six inches to the left, or right, of the sternum line at a height slightly above the belt.
6. Toss the ball to the inside of the ball about to be caught.
7. Watch the balls with a minimum of eye movement.
8. Concentrate on your task.
9. Relax.

In one way the present procedure differed from that of the experiment with college seniors. In the previous study, one group practiced five minutes daily and another group 15 minutes every other day with no interruptions for weekends. In the present study, "daily" was five days a week in physical education classes and "every other day" was three days one week, two days the next, etc. Thus, "daily" was every class period and "every other day" was every other class period.

Results

Table 1 presents the average time required by the high school subjects to learn to juggle. Notice that the mean score for the five-minute group is

TABLE 1

A Comparison of Mean Times Required for High School Students to Learn to Juggle by two Work-Rest Practice Methods

Group	N	Mean	Std. Dev.	Diff.	t	P
Five minutes daily	19	83.53	40.12	65.27	4.59	.01
Fifteen minutes on alternate days	25	148.80	49.49			

83.53 minutes, while the average score for the other group was 148.80 minutes. The significance of the difference between the two means was computed by using the Student-Fisher t-test. A t value of 4.59 was obtained, and this is significant at the 1 per cent level of confidence.

The five-minute daily group learned to juggle significantly faster than the group which practiced 15 minutes on alternate days. In the college investigation, one minute invested by the five-minute group was worth 1.80 minutes spent by the 15-minute group. The ratio in the present investigation was one minute to 1.78 minutes.

Table 2 presents the results of comparing the performances of the high school students with those of the college subjects. No significance was found between the differences in means of comparable groups. A t value of 1.01 was found when the two five-minute groups were contrasted and a t value of 1.39 when the two 15-minute groups were analyzed. Neither of these t values achieves the 5 per cent level of confidence.

TABLE 2

Comparison of Minutes Required by High School Students and College Students to Learn to Juggle

Group	N	Mean	Std. Dev.	Diff.	t	P
5-minute high school	19	83.53	40.12	13.67	1.01	.30
5-minute college	35	69.86	48.20			
15-minute high school	25	148.80	49.49	23.00	1.39	.10
15-minute college	31	125.80	68.60			

Tables 1 and 2 include only subjects who achieved the criterion of 100 consecutive catches. Not shown in the tables is the fact that more high school than college students failed to meet the criterion. In the five-minute groups there were 12 high school subjects who spent at least 165 minutes in practice who never completed 100 consecutive catches, whereas every college student who started met the standard. In the 15-minute groups, there were 21 high school boys who practiced 200 minutes, or more, and still did not meet the criterion, while only four college students did not succeed.

Among subjects who met the standard, college students furnished both the fastest and the slowest learners. In the five-minute groups, the range of the college subjects was from 19 to 210 minutes, while the high school students ranged from 40 to 178 minutes. In the 15-minute groups, the college students ranged from 40 to 278 minutes, while the high school subjects varied from 45 to 235 minutes.

Discussion of Results

The shorter work-test situation produced learning in less practice time for high school subjects, as it did for college students. Thus, the present experiment has obtained additional evidence to support the idea that a shorter work-rest situation reduces the time required to learn.

There was no statistical difference between the time required for the high school boys to learn to juggle and time required by the college students. How can this result be explained? The selective nature of the college subjects and the "mine run" nature of the high school boys makes explanation in terms of maturation only impossible. However, one possibility would be that the task of juggling places no particular premium on such a variable as strength. Examination of the data compiled by Espenschade shows that in one of the athletic performances—target throwing—the oldest boys did not do as well as the youngest boys. In target throwing, there did not seem to be a significant change in performance within the age groups studied. It is quite possible that juggling presents a similar situation. Juggling may place little premium on either strength or other maturational changes customarily occurring between high school freshman and college senior ages.

The increase in the number of subjects who did not meet the criterion deserves comment. Actually, most of these subjects did achieve some measure of success. It might have been reasonable to establish a lower standard for the younger group. If, for example, 25 catches had been the criterion all but three of the five-minute group and all but six of the fifteen-minute group would have been successful. Nevertheless reasons for greater rate of failure in the high school group exist though they are not known. One explanation might be offered in terms of maturity. Perhaps the high school students who failed simply were not physically mature enough for the task. Another explanation might be offered in terms of motivation. Perhaps the "mine run" high school boys had less desire to learn to juggle than did college physical education major or minor seniors.

No significant mental maturational differences were found among the high school students who failed and those who succeeded. Table 3 shows the status of the successful and unsuccessful subjects in terms of mental maturity.

TABLE 3

Comparison of Chronological Age, Mental Age, and Intelligence Quotients of Successful and Unsuccessful Jugglers Among High School Subjects

Group	N	Chron. Age		Mental Age		I.Q.	
		Mean	Range	Mean	Range	Mean	Range
Successful	44	14.3	13-16	189 ms.	148-246	111	77-157
Unsuccessful	33	14.4	14-17	187 ms.	142-286	109	79-159

Another possibility is to explain the increase in failures by the selection which has taken place. Whatever it is that is causing more high school students to fail has kept these boys out of physical education as a major or minor field. High school boys who fail have low motor ability and do not choose a career in physical education. This hypothesis could be tested by securing a sample of non-physical education college seniors and studying their response to the task.

Summary and Conclusions

The present study reports data which were collected as high school freshmen attempted to learn to juggle under two different practice-rest conditions. The subjects in one group practiced juggling three paddle tennis balls for 5 minutes daily until they were able to make 100 consecutive catches, while another group practiced the same skill for 15 minutes every second day. The evidence obtained from the high school freshmen was then compared with the results secured from a previous study group involving college seniors in physical education.

The following conclusions are indicated:

(1) The five-minute daily practice sessions secured more rapid learning than did the 15-minute every second day sessions. This was true for both the high school freshmen and the college seniors;

(2) There was no statistically significant difference between the time required to learn to juggle by the high school freshmen who met the criterion of 100 consecutive catches and by the college seniors in physical education;

(3) There was a sharp increase in the number of failures in the more immature group. These "failures" could have been practically eliminated if a lower criterion of success in juggling (20 to 25 catches) had been established. No explanation has been found in the data available for the increased rate of failure among the high school students.

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Effect of Slow-Motion Loopfilms on the Learning of Golf[1]

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Abstract

The purpose of this investigation was to study the effect of slow-motion loopfilms on the learning of golf. Two groups of beginning golf students were matched on the basis of a pre-test. The experimental group learned golf with the aid of explanation, demonstration, and slow-motion loopfilms, whereas the control group learned the skill with the aid of explanation and demonstration. Five scoring systems were evaluated, and findings indicated no significant differences between groups.

APPARENTLY, the mechanisms involved in learning complex gross motor skills take years to develop and the process is a matter of great concern to physical educators, since the individual changes that take place are beyond present comprehension. Various teaching methods have been continuously applied to bring about more efficient learning and research has contributed valuable information which seems to favor improved performance in physical activities.

The value of the motion picture as an aid in learning has been pointed out by a number of people (3,6,10) in a variety of ways, and most of the research has indicated that use of films may help at various stages of the learning process. Although most of the studies lack statistical significance, there seems to be a trend toward improved learning when the motion picture is used. Procedures have varied from 2½-minute loopfilms (3) to complete 30-minute instructional films (10); from normal speed to extremes in slow motion; from individualized instruction along with the motion picture to mental practice with no outside instruction while viewing the picture.

In a study of competitive-athletic-type skills, researchers have found improved performance occurring when films of various kinds were used (8, 11). Football coaches today find the motion picture a valuable technique in teaching their teams. Short loopfilms, both in normal and slow motion, of fundamentals of many activities are used universally by coaches. They are used in many different ways, and as yet there appears to be no "best" way of adapting their use, nor is it certain as to the contribution of films in the learning process.

One factor in the conflict concerning the value of the motion picture and other problems in using visual aid seems to be in the conditions under which the visual aids are used (4). The emphasis on the use of motion pictures now

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[1]This study was supported by Utah State University Research Funds.

appears to be on improved techniques which involve such procedures as slow motion, the making of short loopfilms, and adapting the use of cinematography to the gynasium, various sports areas and to the instruction program for the individual performer in different activities.

Statement of the Problem

The purposes of this investigation were: 1. To adapt, in a general way, the use of motion pictures to the teaching of golf at the time and place of learning, and 2. To study the effect on learning golf when slow motion loopfilms were employed.

Procedure

In order to meet the foregoing objectives, it was necessary to investigate two phases of the problem. First, the 16 mm slow-motion pictures were made of the golf swing, using a seven iron. The action shots covering the complete fundamental activity were filmed, edited, and cut by the writer into short lengths of approximately seven feet. The ends were spliced together to form a short loopfilm which could be viewed over and over again. After the loopfilms were prepared, viewing conditions were studied using the radiant screen. Secondly, short loopfilms used in the study were of two good golfers (male and female) using the seven iron under the same conditions as those in the experimental procedure. Two different angles were used—partly facing the subject at a 90° angle from the line of flight; and partly facing the subject at a 45° angle from the line of flight.

The entire experiment was conducted on the Utah State University football field. The scoring factor made it necessary to choose a place where the skill could be scored objectively, and the stadium seemed to meet this requirement adequately. A standard golf flag target was placed on the 50-yard line and subjects were located along the end line of the field 60 yards away. Each subject hit 30 golf balls with a seven-iron from the same location each day.

The teaching of the golf skill was on the beginning level and involved a verbal explanation of general and specific principles found in golf. This was followed by a brief demonstration of the skill. The majority of the principles chosen were specific and applied directly to golf. However, a few principles applied to many different activities. As an example, it was pointed out that movements of the head cause other parts of the body to move, which in turn can influence total bodily movement patterns. The specific golf principles were according to those recommended by Novak (7). All subjects were given the same principles, and the instruction was uniform within both groups.

Forty-seven adult men and women were used as subjects, and for the most part, they had never swung a golf club. Fifteen were men and 32 were women, with equal numbers of each sex in the experimental and control

groups. Since it is impossible to control past experiences, in order to attempt equalization of the groups each subject was given a pretest which consisted of one day's total score, or the recorded score of 30 balls. Two matched groups were then formed on the basis of scoring on the pretests. The total number of scores was arranged from highest to lowest, after which individual cases of high and low scores were placed in two groups. Twenty-three people formed the experimental group, and 24 the control group. One person from the experimental group failed to complete the study, which accounted for the uneven numbers.

The experiment covered five weeks of instruction. Mondays, Wednesdays, and Fridays of each week were utilized for a total of 15 days, one hour each day. Subjects were paired during the practice sessions, one scoring the hits and one driving balls. All balls were plotted in relation to the target and scored on the basis of concentric circles five yards apart with the flag in the center. The innermost circle received a value of ten, and each succeeding circle from the target was assigned a value of one less. Fifty yards away from the flag the score was zero. All subjects received instruction using the foregoing teaching procedures, which were given by the investigator. In addition, the experimental group viewed the slow-motion loop-films five minutes before each session, and five minutes midway during each practice session. Individualized help was given during the film, as well as directed attention to what should be observed. Individualized help was also given to the control group, but they were not afforded the use of the films.

Since space limited the number of subjects at any one session, four different groups were used in the study. Three groups contained some experimental and some control subjects, although no control group members were permitted to view the films, nor was there any discussion among personnel of each group during the sessions. Subjects were so diverse that it is doubtful any discussion took place at any time. The fourth and smallest group was entirely a film group. This happened to be the arrangement after matching of groups had been completed. The movies were shown in the tunnel of the stadium leading to the football field. This area was shaded but not dark.

Data were derived and checked from five different scoring techniques: 1. The use of final day scores; 2. The difference between the first and final day scores (a measure of improvement which is also related to the first system); 3. The sum of all scores (1); 4. Per cent-of-possible gain method (1); 5. Comparing scores in groups of five—total of first five scores, second five scores, and third five scores. It is recognized that the techniques selected are not the only measures of motor learning, but they seem to be objective devices which indicate achievement of some kind. Statistical comparisons of the two groups were made by checking the significance of the difference between the mean scores (5).

Results

The purpose of this investigation involved a study of the effect of slow motion loop films on the learning of golf. The evaluation of the significance of the difference between the observed means of the two groups, using the first two scoring methods—final scores and the difference between the first and last scores—is shown in Table 1. The means of each group, regardless

TABLE 1
Means and t-Ratio for Groups Learning Golf

Group	Means	D	S_d	t ratio
Final Scores		7.19	9.09	.791 $P > .05$
Experimental	225.91			
Control	218.42			
Difference between first and last scores		8.74	14.01	.623 $P > .05$
Experimental	57.57			
Control	48.83			

of the two scoring techniques used, were not found to be significantly different, although in both scoring methods the experimental group finished the learning period with higher scores.

The data in Table 2 indicate that the rate of learning was fairly uniform between groups. The only days that the experimental group was found to

TABLE 2
A Comparison of Daily Group Means in Learning Golf

Days	Mean Scores		Days	Mean Scores	
	Experimental	Control		Experimental	Control
1	168.04	169.58	9	194.65	211.79
2	174.78	172.42	10	198.91	211.75
3	175.70	188.33	11	207.65	209.08
4	179.83	182.75	12	212.83	212.49
5	171.39	184.46	13	207.17	212.92
6	190.95	193.21	14	207.35	211.71
7	193.87	201.29	15	225.61	218.42
8	187.61	200.71			

be superior to the control group were the second, 12th and 15th (final) days. The learning curve does not seem to differ appreciably between groups, as noted in Figure I. For the most part, the control group was found to record slightly better scores during most of the fifteen days. An examination of Table 3, which shows the total score method of scoring, indicates the control group to be slightly superior to the experimental group, although not significantly different.

It seems that group percentage comparisons are questionable techniques to be used, but when means were computed using Brace's (1) per cent-of-

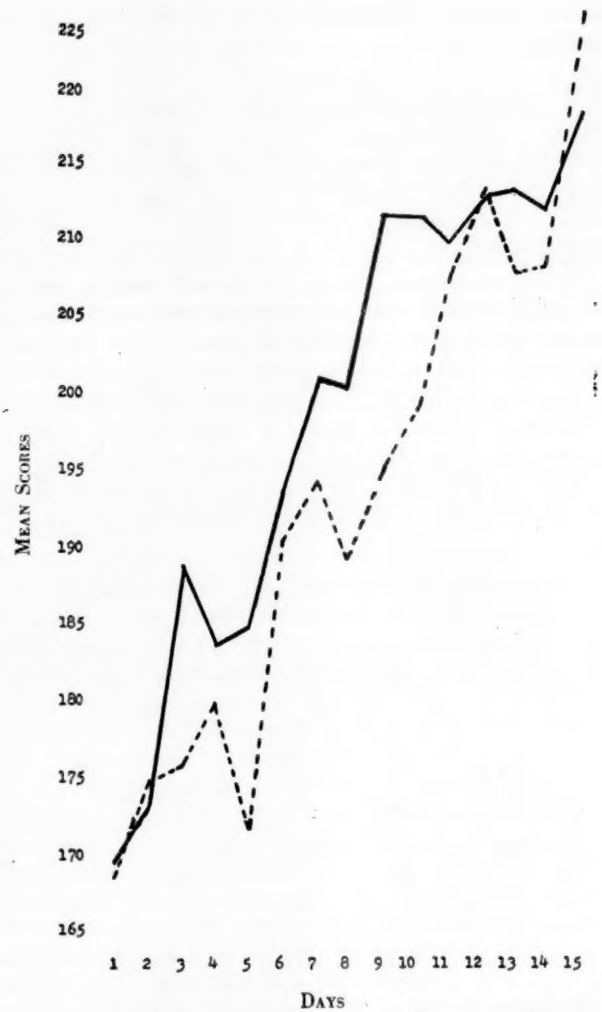

FIGURE I. Experimental ------- Control———

TABLE 3

Means Using Total Score Method

Group	Subjects	Total Score	Mean
Experimental	23	66605	2896
Control	24	71552	2981

possible-gain method, it was also found that the control group was slightly superior (Table 4).

TABLE 4

Means Using Per-Cent-of-Possible-Gain Method

Group	Mean Per Cent
Experimental	56.35
Control	58.31

Since scores vary from day to day, it was felt that scores in groups of five would give a more accurate picture of a person's starting and stopping point, as well as his progress. The data were evaluated on this basis to try to determine any variations not indicated in the first four mentioned scoring techniques. Table 5 shows that the control group started with a slightly higher mean score on the first five days and gained more during the second five days. This group gained 121 points, as compared with 97 for the experimental group. However, the experimental group indicated a greater gain on the third five days' score, 95 as compared with 46 for the control group. Total gain was also in favor of the experimental group, 192 compared to 167.

TABLE 5

Scores in Groups of Five Days

Group	First five days' score	Gain	Second five days' score	Gain	Third five days' score	Gain
Control						
Mean	898	121	1019	46	1095	167
S.D.	184.8		161.7		140.9	
Experimental						
Mean	869	97	966	95	1061	192
S.D.	204.3		155.6		143.7	

It would ordinarily be assumed that the lowest part of each group would make the greatest gain, since learning is usually more rapid on the lower levels. In order to see if there were any different effects of the films on the upper and lower 25 per cent of each group, the data were evaluated for the upper six and the lower six starting scores (first five days' scores). It was found that the control group in the lower 25 per cent gained more over-all and in the last five days, but the experimental group gained more during the second five days (Table 6).

In the upper 25 per cent, the experimental group gained the most over-all and in the last five days, whereas the control group gained the most during the second five days (Table 6).

TABLE 6

Upper and Lower 25 Per Cent Scores in Groups of Five Days

Group	First five days' score	Gain	Second five days' score	Gain	Third five days' score	Gain
	Lower 25%					
Control Mean	683	166	849	123	972	289
Experimental Mean	618	208	826	57	883	265
	Upper 25%					
Control Mean	1145	45	1190	19	1219	64
Experimental Mean	1111	3	1114	91	1205	94

Discussion

The question of superiority of teaching method is important, since the little understood learning process seems to react differently under various sets of conditions. Ruffa (11) and Priebe and Burton (8) indicate a marked superiority in the early stages of learning when movies were used, whereas Lockhart (6) found the most value after bowlers had had about two weeks of instruction. For the most part, this study fails to agree with the above-mentioned studies, although when the scores in groups of five were evaluated, the data indicated the same trend as was found in Lockhart's (6) study. The upper 25 per cent of the group also seemed to follow this pattern, but the lower 25 per cent of the film group showed greater gains in the early stages of learning, as did the groups in the studies of Ruffa (11) and Priebe and Burton (8). If these figures are any indication of pattern, the loopfilms are beneficial to the more skilled in the later stages of learning and to the less skilled in the early stages. For the group, however, the loopfilms seem to be most advantageous in the later stages of learning. Since the investigation found the film group superior on the 15th or final day, it would be interesting to see if this superiority would be maintained at subsequent levels of learning.

It seems logical to assume that varied conditions in the use of motion pictures would contribute to variations in the learning of certain gross motor skills. Almost all recorded studies have used the motion picture in different ways, which could easily account for recorded differences.

Ragsdale (9) points out that when an activity is presented to a beginner at slowed speed, it introduces important changes in his movements when he slows them down. He says these slowed movements are radically different from fast movements in terms of muscle contractions, nerve impulses, etc. It is agreed that this is the case if the student actually performs the skill in slow motion, but whether this is the same situation resulting from

viewing slow-motion films is another question. It seems that slow-motion pictures can do a better job of pointing out the things that are taking place and the relationship of parts to the whole in a clearer way than when the motion is at normal speed. If this is what happens, motion pictures should be of some value during the learning process.

There is a possibility, as Davis and Lawther (2) point out, that too many different techniques are presented in a short period of time and there would be interference until these "many" aspects of the learning situation were fully integrated. The present study seems to be best explained by this particular reasoning, since important differences did not appear until the final stages of learning, and even then important changes are questioned. This, however, could not be substantiated until later stages of learning were observed.

Conclusions

The findings of the study were not found to be statistically significant, nor do they necessarily agree with expectations of other researchers in this area; hence, it is difficult to make sweeping conclusions which are fully substantiated. It is also recognized that the things that happened in golf instruction may be entirely different in the learning of other skills. The following findings seem to be justified within the limits of the study:

1. Both groups made gains in learning as evidenced by the scoring techniques.
2. The variability of both groups decreased significantly with practice.
3. Both groups became more homogeneous with practice, but not significantly different from each other.
4. Most of the movements found in activities are performed so fast that the naked eye cannot follow them and technical aspects are difficult to teach. Consequently, motion pictures appear to help the instructor point out the intricacies of complex gross motor movements.
5. Slow-motion loopfilms seem to favor the learning of golf, in the later stages of learning, but not in the early stages. A further breakdown indicates greater learning in the early stages for the lower levels and greater learning in the later stages for the upper levels. Differences were not found to be significant. At any rate, without undisputed evidence to the contrary, it is illogical to assume that anything is lost when slow-motion loopfilms are used. Certainly the possibilities for gains should not be ignored.

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An Electrocardiographic Study of United States Olympic Free Style Wrestlers

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Abstract

Electrocardiograms were recorded from 74 wrestlers who competed in a tournament to select members of the 1956 Olympic Free Style Wrestling Team. In general, their electrocardiograms did not differ strikingly from those reported in the literature for healthy non-wrestlers of equivalent age. There was no evidence from this study that arduous training and competition in amateur wrestling over an extended period of time produced pathologic changes in the normal heart.

IN MAY, 1956, the candidates for the United States Olympic Free Style Wrestling Team assembled in Hollywood, California, to participate in a tournament designed to select the members of the squad to compete in the Olympic Games at Melbourne. In an attempt to determine whether there are characteristic electrocardiographic findings which differentiate the highly trained wrestler from the non-wrestler, the investigators recorded and analyzed pre-tournament electrocardiograms from 74 of the contestants. The results are presented in the following report.

Review of the Literature

The spread of the electrical impulse through the auricles is represented by the P-wave. The amplitude of this wave does not usually exceed 2.5 mm. in any lead, and Cureton (5) observed that low P-waves were associated with endurance in treadmill running. Hoogerwerf (10) attributed low amplitude P-waves to strong vagal influence.

The P-R interval represents the time required for the electrical impulse to travel from the sino-auricular node to the ventricular muscular mass. The upper limit of the normal duration of the P-R interval has been stated as 0.21 second for large adults whose heart rate is below 70 beats per minute (3); however, Sodi-Pallares (23) affirmed that prolongation of the P-R interval may result from hypervagotonia following prolonged strenuous exercise. Cureton (5) asserted that short P-R intervals were correlated with endurance. In his study of three groups of athletes, the P-R interval ranged from 0.12 to 0.22 second in lead II (6). Subsequently, he reported that the

electrocardiogram of Robert Richards showed a P-R interval of 0.32 second, and Rasch and his associates (19) observed a P-R interval of 0.27 second in the electrocardiogram of James Bailey.

The QRS complex, which represents the spread of the electrical impulse through the ventricles, does not normally exceed 0.10 second (10). In Glasser's (9) series of 193 athletes, there were only four whose electrocardiograms showed QRS intervals exceeding 0.11 second. Cureton (5) reported that in his observations of champion athletes the duration of the QRS complex ranged from 0.06 to 0.10 second. The mean normal electrical axis of the QRS complex is about 58° for adults (10).

The Q-T interval represents the duration of ventricular systole. The normal duration for a given heart rate can be computed by a Freibrun calculator or other similar aid. Prolongation of the Q-T interval is considered by Sodi-Pallares (24) to be one of the signs of so-called "athlete's heart." Although he did not define this term, he apparently associated it with ventricular hypertrophy. Marriott (14), Sokolow and Lyon (25), and Scott and his co-workers (20) suggested various other electrocardiographic abnormalities indicative of this latter condition. Scott and his associates presented a convenient review of the subject.

The T-wave is believed to represent the recovery period of the ventricles. The U-wave, according to some authorities, represents repolarization of the papillary muscles and neighboring structures and is sometimes absent or immeasurable (7). Hoogerwerf (10) reported that the U-wave was only rarely present in the electrocardiograms of the 212 Olympic athletes whom he examined.

Some doubt exists as to the value of the electrocardiogram in the study of cardiac function in athletes. As Katz (11) pointed out, it provides no information regarding the power of the heart, the vigor of its contraction, or its tone. Cooper, O'Sullivan, and Hughes (4), who observed oarsmen before a period of training and again three to four months later, reported only one striking change in their electrocardiograms recorded at the end of the training regimen: an increase in the amplitude of the T-waves in lead I. Inverted T-waves in lead III were "very common." Tuttle and Korns (26) reported that there was little change in the electrocardiograms of 48 varsity athletes at the beginning and termination of their sports season and added that, according to the observations of Kraus and Nicolai (12), electrocardiograms of trained athletes at rest were essentially the same as those of untrained men, with the exception that the T-waves tended to be higher.

Messerle (16) asserted that training caused an increase in the amplitude of the T-waves and greatly increased the duration of the QRS complexes, which changes he attributed to increased vagal influence. Beckner and Winsor (1) stated that the electrocardiograms of marathon runners showed characteristic features; namely, a slow cardiac rate with high voltages in

the QRS complexes and in the T- and U-waves, which these investigators considered typical of right and left ventricular enlargement without evidence of cardiac disease.

Comparatively little information has been published concerning electrocardiographic studies of wrestlers. Reporting a study of the electrocardiograms of sumo wrestlers, Miyama (17) stated that the waves were somewhat larger than normal, the amplitude being proportional to the weight of the athlete, and that left axis deviation was evident. The latter he attributed to the elevated diaphragms of those corpulent wrestlers. In a similar study of the electrocardiograms of a group of German professional wrestlers, Meister and Kowalzig (15) observed inverted T-waves in lead III, which they considered typical for these athletes. German authorities, in general, are said to ascribe inversion of the T-waves in leads II and III to excessive training (13), although it is the opinion of Sodi-Pallares (23) that inverted T-waves in lead III may be entirely normal. Moreover, he stated that in the electrocardiograms of some Mexican professional jai alai players, the T-waves were inverted in the tracings recorded before exercise and upright in those obtained immediately after exercise.

Procedure

At the time of weighing in, the investigators recorded the name, height, weight, years of experience, and other pertinent data on the 74 wrestlers who volunteered as subjects. The ages of these subjects ranged from 16 to 47 years. By means of a Burdick Type EK-2 direct writing electrocardiograph, a standard 12-lead electrocardiogram was obtained from each subject while he lay supine on a plinth. Individuals who had had breakfast were not accepted as subjects, since it is known that the process of digestion alters the electrocardiographic picture (8,12).

The portions of the tracings believed to be the most significant were measured. These measurements were then tabulated according to the weight classifications of the wrestlers. The mean figures for each class, as well as the means for the entire group, are presented in Table 1. The group means are based on the individual figures of the entire series rather than on the means of the different weight groups of wrestlers.

Results and Discussion

A review of the data summarized in Table 1 fails to indicate any positive relationship between the weights of the subjects and the amplitudes of the various electrocardiographic waves. With the possible exception of some of the heavyweight wrestlers, each subject was, to a greater or lesser degree, below his normal body weight as a result of the training regimen. In a homogeneous group, such as Miyama's, in which every individual was obese and presumably had a comparatively more horizontal heart, there may be

TABLE 1

Summary of Mean Electrocardiographic Data

Weight Class (lb.)	No. Subjects	Heart Rate (*per min.*)	Amplitude P-Wave L-II (*mm.*)	P-R Interval L-II (*sec.*)	Q-T Interval L-II (*sec.*)	Amplitude $S\text{-}V_1$ + $R\text{-}V_5$ (*mm.*)	Amplitude $T\text{-}V_5$ (*mm.*)	QRS Interval L-II (*sec.*)	QRS Axis (*degrees*)
114.5	6	73.3	1.13	.14	.385	30.3	5.3	.07	79
125.5	12	61.8	.97	.16	.401	32.4	5.1	.08	49
136.5	10	58.0	1.03	.15	.418	32.4	5.1	.09	75
147.5	11	63.9	.77	.15	.402	28.8	4.4	.08	66.5
160.5	10	62.1	1.25	.14	.408	28.3	5.4	.08	54
174.0	12	68.6	1.06	.16	.400	28.9	4.5	.09	61
191.0	5	62.2	1.00	.15	.402	31.0	5.2	.09	65
Heavy weight	8	68.9	1.06	.17	.388	25.8	5.8	.10	46
Total Group Mean	74	64.5	.94	.15	.4017	29.9	5.1	.085	61

correlations between body weight and amplitude of the waves which are not apparent in heterogeneous groups.

The mean amplitude of the P-waves in lead II was 0.92 mm., which is consistent with the findings of Cureton (5) and according to his theories, is suggestive of good endurance in these wrestlers. Very few measurable U-waves were observed in these records.

The mean P-R interval of 0.15 second was surprisingly short, and in only one instance was it longer than 0.22 second. The mean was near the lower limit of the ranges observed in three groups of athletes examined by Cureton (6) and was below the mean of any one of his groups. According to his observation that short P-R intervals correlated with endurance, this short mean P-R interval would indicate good endurance in these wrestlers. However, the fact that Landy and Bailey had P-R intervals of 0.18 and 0.27, respectively (19), raises some question about this interpretation.

The mean observed Q-T interval in this study was 0.4017 second, and the mean heart rate, 64.5 beats per minute. The mean normal Q-T interval, as computed by a Freibrun calculator, was 0.3779 second. However, Sodi-Pallares (24) stated 0.375 ± 0.04 second as the normal Q-T interval for a heart rate of 65; hence, it appears that the mean Q-T interval, although longer than that ascertained by a calculator, was still within normal limits.

The mean QRS interval for these electrocardiograms was 0.085 second, a figure well within the range reported for Cureton's champion athletes (5). However, several records showed a QRS interval of 0.11 or 0.12 second, and in one instance, 0.13 second. In the opinion of Marriott (14), a QRS interval of 0.11 second should be considered normal, whereas an interval exceeding 0.12 second is indicative of abnormal intraventricular conduction and usually suggestive of a block. In the absence of definite evidence of bundle branch block, a QRS interval of 0.10 second or more may indicate some degree of left ventricular hypertrophy. The Wolff-Parkinson-White syndrome was evident in the electrocardiogram showing a QRS interval of 0.13 second, which was recorded from a wrestler who was eliminated in the semi-final round. It has been suggested that this relatively benign syndrome is present when one ventricle is activated early by the bundle of Kent, which by-passes the auriculoventricular node, and it is said to be found primarily in males without evidence of heart disease (24). The mean electrical axis of the QRS complex in these electrocardiograms was 61 degrees.

By the criteria of Marriott, 27 of the electrocardiograms showed evidence of left ventricular hypertrophy, the combined amplitude of the R-wave in lead V_5 and the S-wave in lead V_1 being in excess of 30 mm. By the stricter criteria of Sokolow and Lyon, only 14 of these 27 electrocardiograms showed indications of left ventricular hypertrophy, the amplitude of the same combined measurements being over 35 mm. When Wilson's various criteria, as presented by Scott and his co-workers (20) were applied to all of the 27

electrocardiograms, only 12 showed signs of left ventricular hypertrophy, indicated in each tracing by displacement of the transitional zone to the left, a sign not altogether reliable; and six of these electrocardiograms were among those which did not meet the criteria of Sokolow and Lyon. This diversity suggests the necessity for caution in interpreting the electrocardiograms of athletes, particularly when employing the criteria thus far proposed for the diagnosis of left ventricular hypertrophy.

Sixteen of the electrocardiograms (21.6%) showed inverted T-waves in lead III. Since, in the tracings of normal subjects, inversion of the T-waves in lead III is frequently attributed to a transverse position of the heart, it was interesting to observe that in the large majority of our subjects the heart tended to be in the vertical position. Of those electrocardiograms with inverted, diphasic, or flat T-waves in lead III, only nine showed evidence of left ventricular hypertrophy by the criteria of Marriott. No evidence of right ventricular hypertrophy was observed in these electrocardiograms.

The mean amplitude of the T-waves in lead V_5 in this series was 5.1 mm., which compares closely with the mean amplitude of 4.5 mm. reported by Cureton (5) in his study of middle distance runners. Remarkably tall T-waves were observed in 26 of the electrocardiograms. Unlike Cureton's series (6), the tallest T-waves were present in the left ventricular leads in only 12 electrocardiograms; the tallest T-waves were observed in the right precordial leads in five tracings and in the transitional zone in nine tracings.

Nine (12%) of the electrocardiograms in this series showed double positivity of the QRS complex in the right precordial leads or embryonic R-waves superimposed on the S-waves in the right precordial leads, which, according to Sodi-Pallares (24) are indicative of incomplete right bundle branch block. This is frequently observed in the tracings of children and young adults and is not necessarily pathologic. In three of these nine tracings there was considerable notching of the QRS waves in the limb leads. Fifteen others, not in this group of nine, showed notching of the QRS waves in the limb leads without changes in the precordial leads. The significance of these changes is questionable.

Most of the electrocardiograms reviewed in this study revealed sinus arrhythmia, which is said to be characteristic of the tracings of young adults. The electrocardiograms of two wrestlers showed slow heart rates (45 in one, 68 in the other) and aberrant rhythm (auriculoventricular nodal rhythm). This latter abnormality results from origination of the impulse for cardiac contraction in the auriculoventricular node instead of in the usual site, the sino-auricular node. Although the impulse spreads from the auriculoventricular node to the ventricles in the usual manner, the auricle is activated by retrograde conduction. The electrocardiogram of one of these two subjects showed no other unusual findings; the other presented unusually large T-waves in the precordial leads and evidence of left ventricular hypertrophy.

It is of interest that this subject remarked that he possessed unusual endurance and had won most of his matches late in a bout after having exhausted his opponent.

In general, the resting heart rates of these athletes were slower than had been anticipated; in two instances, the rate was only 41; in others, it ranged between 41 and 50. These rates are comparable with those reported for such noted distance runners as Cunningham (27) and Hagg and Anderson (18). Some of the subjects with extreme bradycardia remarked that while en route to California they found it necessary to get up at intervals and walk about in the train to overcome a sensation of "passing out." Apparently, these men had never traveled a considerable distance by rail before, and the sensation of "blacking out" was novel and disturbing. The mean heart rate of 64.5 for the group was only slightly above the rates recorded at the 1928 Olympic Games by Bramwell and Ellis (2) for long distance runners (61) and for middle distance runners (63). Hoogerwerf commented, "Strangely enough, the athletes feel perfectly well in spite of this great bradycardia" (10), but Slapak (22) observed that in athletes severe bradycardia may occur on a purely physiological basis. Further study of the long-range effects of extreme bradycardia on health is needed.

Conclusions

The findings of this study support the following conclusions:

1. Generally, the electrocardiograms of these highly trained amateur wrestlers were not strikingly different from those reported in the literature for healthy non-wrestlers of equivalent age.
2. There was no evidence from this study that arduous training and competition in amateur wrestling over an extended period of time produced pathologic changes in the normal heart.
3. Because of the lack of agreement between the various electrocardiographic criteria for left ventricular hypertrophy, too much reliance should not be placed on interpretations made by these means alone.
4. The presence of unusual electrocardiographic findings in three highly successful wrestlers (auriculoventricular nodal rhythm in two and Wolff-Parkinson-White syndrome in one) did not appear to be associated with physical impairment.
5. Further studies are needed to determine the ultimate effects of marked bradycardia.

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Effects of a Combative Sport (Amateur Wrestling) on the Kidneys

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Abstract

The purpose of this investigation was to study the effects of amateur wrestling on the kidneys, as indicated by changes in the composition of the urine. Urine samples were obtained from sixteen college wrestlers before and after participation in a wrestling tournament, and forty hours after competition. Competition tended to produce the following changes in the composition of the urine: increased acidity, the appearance of albumin, an increase in the number of casts, the appearance of red blood cells, and the appearance of sugar. After the forty hour post-competition period, these factors tended to return to the pre-competition levels. These transient symptoms did not appear to indicate permanent injury to the kidneys.

IN RECENT years the possibility that combative sports have traumatic effects on the kidneys of the athletes has aroused considerable interest. No reports concerning the effects on these organs of intercollegiate or free-style wrestling have been found in the literature, although studies have been made of the effects on renal function of boxing and football, as well as of certain non-combative activities. It was the purpose of this research to study the effects of amateur wrestling on the kidneys, as indicated by changes in the composition of the urine of wrestlers following competition and following a post-competition rest period.

Review of the Literature

A convenient summary of the information which can be obtained by laboratory examination of the urine has been given by Stasney and Jernstrom (11). Freshly voided urine is usually clear, although a fine precipitate of earthy phosphates may produce turbidity in normal specimens. The hydrogen-ion concentration varies from a pH of 4.8 to 8.0, the mean being about 6. The specific gravity usually ranges from 1.006 to 1.025. An insignificant amount of protein (albumin), said to be plasma protein from the kidneys, is often present after severe muscular exertion (4), and transitory glycosuria may also be observed after exercise. Hematuria, which may be ascertained by gross or microscopic examination, may accompany renal trauma. Hyaline or granular casts are often present in the urine of healthy individuals after exercise.

It is generally agreed that renal function is affected by heavy muscular work (6). Investigators have cited certain specific changes in renal function

which are produced by exercise; namely, a decrease in urinary output, an increase in specific gravity, a reduction in renal plasma flow and filtration rate, a decrease in the chloride concentration, an increase in urinary acidity, ammonia and phosphates, and perhaps albuminuria (7, 12).

As early as 1910, Barach (2), after studying renal function in marathon runners, concluded that the more serious the disturbance of the general circulatory system, the more marked were the evidences of the disturbance in the renal circulation, as evidenced by the degree of hematuria, albuminuria and/or cylindruria (presence of casts). Ten years later he reported a study of 57 baseball players and track men (3), 85 per cent of whom showed increased acidity of the urine. The presence of albumin and casts did not appear to be related to pH. After exercise, albuminuria was present in 77 per cent of his subjects. Analyses of samples obtained after the subjects had exercised by running disclosed hyaline and granular casts and a few red blood cells in 71 per cent, whereas specimens obtained after baseball games showed hyaline and granular casts or red blood cells in 23 per cent. Urinary acidity was not reported more frequently following severe exertion than after mild exertion, nor was the degree of acidity higher.

Amelar and Solomon (1), whose subjects were 103 professional boxers, reported that comparison of the results of urinalyses of samples obtained both before and after a bout revealed the following changes: The samples of 46 per cent of the subjects whose urine was clear before the bout became turbid immediately after competition; in 80 per cent the specific gravity increased; traces of acetone were noted in 14 per cent; the pH decreased in 39 per cent; sugar was present in 9 per cent; albumin, which was not present in the specimens examined before the bout, was observed in 68 per cent of the samples obtained after competition; red blood cells were present in significant numbers in 73 per cent after competition; and granular or hyaline casts were present in 26 per cent. These invetigators concluded that, in addition to an exercise effect, these boxers suffered acute trauma to the kidneys, the severity correlating with the duration of the fight. This observation resulted in their recommending that a urinalysis should be part of the routine physical examination of boxers, and that a boxer should not be permitted to compete unless the findings were normal.

Boone, Haltiwanger, and Chambers (5) studied the effects of participation in football on renal function. Urine samples obtained from members of the varsity football team of a major university were examined in the laboratory for color, turbidity, pH, specific gravity, albumin, sugar and microscopic findings. In many of the players the preliminary conditioning exercises produced albuminuria, casts and microscopic hematuria; and as their physical activities became more strenuous under the conditions of actual competition, the incidence of these abnormalities increased. A defiinte peak in the incidence of hematuria was observed in the specimens obtained after each game, although this abnormality disappeared promptly after rest. Accordingly,

these investigators concluded that the presence of microscopic hematuria did not warrant restriction of the activity of the players.

Selman and Gualano (10) examined laboratory reports of urine samples obtained from high school football players before and after two games. Of the 23 samples that were examined and reported clear before the game, 16 of the paired post-exercise samples exhibited some turbidity. The mean specific gravity of 26 pre-exercise samples was 1.0285, of 25 post-exercise samples, 1.0302. This change was statistically significant. Of the pre-exercise samples, 13 showed an alkaline reaction, 12 an acid reaction, and two were neutral. All 27 samples obtained after the game were acid. One pre-exercise sample showed albumin, which persisted in the specimen obtained after the game. The remaining 26 samples obtained before the game were albumin-free; however, 92 per cent of the paired samples obtained after competition manifested albumin. All 27 pre-exercise samples were aglycosuric, and only one showed a positive reaction for sugar following exercise. None of the pre-exercise samples contained casts; however, 22 of the 27 post-exercise samples (81 per cent) contained hyaline and/or granular casts. In only one post-exercise specimen were there more than a few red blood cells present. On the basis of the results of their study, these authors concluded that football is not likely to be more injurious to the kidneys than other comparable forms of exercise without bodily contact.

Gardner (8) asserted that protein, hyaline, and granular casts, red blood cells and other formed elements may appear in the urine of athletes during the athletic season without other evidence of glomerulonephritis. He proposed the term "athletic pseudonephritis" for this phenomenon.

Procedure[1]

The subjects for the investigation described herein were members of a major university wrestling squad. Early on a Saturday afternoon the varsity members of the squad participated in an intercollegiate dual meet. Later in the afternoon, the entire squad entered an Amateur Athletic Union tournament, which concluded shortly before midnight. A urine sample was obtained from each subject shortly before competition and shortly after his last bout.

After determination of the pH by Hydrion papers, the urine samples were refrigerated until Monday morning, at which time routine urinalyses were performed in the laboratory. On Monday afternoon a third sample was obtained from the subjects before their workouts in order to evaluate the effects of the 40-hour post-competition period. After determination of the pH by Hydrion papers, the specimens were refrigerated until the following morning, when routine urinalyses were performed in the laboratory.

[1]The investigators wish to express their appreciation for the assistance rendered by Fred H. Paseman, Supervisor of the Clinical Laboratory, College of Osteopathic Physicians and Surgeons, who supervised the clinical laboratory tests.

Results and Discussion

The results of the series of urinalyses are summarized in Table 1. Values for specific gravity were not included in the summary, since in some instances the sample was insufficient for this test.

Of the 16 wrestlers included in this study, the urinalyses of eight (50%) showed a reduction in pH immediately following competition. This increase in acidity was probably related to the acid metabolites of exercise. Since accumulation of metabolites depends in part on the relative intensity of exercise (9), this suggests that, as a whole, these wrestlers may have exercised more strenuously than the boxers studied by Amelar and Solomon, but not as strenuously as the football players studied by Selman and Gualano. However, there appeared to be no consistent relationship between the number of bouts in which the subjects competed and the change in pH, which may reflect individual variations in physical fitness, severity of competition, or style of wrestling.

Analyses of the urine samples obtained at the end of the 40-hour post-competition period showed increased alkalinity, in most instances to a degree slightly exceeding the pre-exercise level. The extent to which this finding may have been influenced by diet during this period is unknown.

Immediately after competition, albumin was present or increased in 11 subjects (69 per cent), including two whose tests showed albumin (1 plus) before competition and a like amount (1 plus) in the paired samples examined at the end of the 40-hour post-competition period. The presence of albumin in the urine following strenous exercise may have indicated a decreased fluid volume as a result of exercise, which created a temporary irritation of the tubules of the kidneys and consequent moderate loss of albumin. Albuminuria may also be explained on the basis of altered protein metabolism as a result of exercise (9). The disappearance of the albumin in the samples examined at the end of the 40-hour post-competition period, with the exception of the two that were positive for albumin before and immediately following competition, indicated that these subjects had suffered no injury to the kidneys.

Urinalyses showed casts in the specimens obtained from three wrestlers (19 per cent) following competition. In all three instances, the casts disappeared in the specimens obtained after the post-competition period. Other than reflecting the severity of the exercise, the temporary increase in the number of casts was believed to have comparatively little significance. In only one instance did sugar appear in the urine following wrestling competition.

In marked contrast to the reported findings of previous studies, only random changes were observed in the number of red blood cells present in the urine following strenuous competition. It is possible that red blood cells appeared in the urine as a result of trauma to the kidneys; however, Barach's report that laboratory tests revealed the presence of red blood cells in the urine of a large percentage of the baseball players he studied supports the

TABLE 1
Analysis of Urine Samples

Subject	Age	No. Bouts	Time of Sample	Visual pH	Laboratory Findings				
					pH	Alb.	Sugar	RBC's	Casts
1	25	5	Pre-Comp.	4	5.0	0	0	0	0
			Post-Comp.	4	4.5	2+	0	0	0
			40 Hr. P.C.	5	5.5	0	0	0	0
2	21	4	Pre-Comp.	7	5.0	0	0	0	0
			Post-Comp.	4	4.5	2+	0	0	0
			40 Hr. P.C.	6	5.5	0	0	0	0
3	20	4	Pre-Comp.	4	5.5	0	0	0-3	0
			Post-Comp.	4	5.0	3+	0	0-1	0
			40 Hr. P.C.	–	4.5	0	0	0	0
4	21	3	Pre-Comp.	7	6.0	0	0	0-2	0
			Post-Comp.	4	4.5	Tr.	0	0	0
			40 Hr. P.C.	6	7.5	0	0	0	0
5	25	3	Pre-Comp.	8	7.0	0	0	0	0
			Post-Comp.	4	5.5	0	0	0	0
			40 Hr. P.C.	7	7.5	0	0	0	0
6	25	4	Pre-Comp.	7	6.5	0	0	0	0
			Post-Comp.	4	5.5	0	Tr.	0	0
			40 Hr. P.C.	7	7.5	0	0	0	0
7	20	3	Pre-Comp.	4	5.0	0	0	0-1	0
			Post-Comp.	4	4.5	0	0	2-4	0
			40 Hr. P.C.	4	4.5	0	0	0	0
8	17	3	Pre-Comp.	4	5.5	0	0	0	0
			Post-Comp.	4	5.0	2+	0	0	0
			40 Hr. P.C.	6	7.0	0	0	0	0
9	20	2	Pre-Comp.	4	5.5	0	0	0	0
			Post-Comp.	4	4.5	3+	0	0	0
			40 Hr. P.C.	6	7.0	0	0	0	0
10	21	3	Pre-Comp.	7	6.5	0	0	0	0
			Post-Comp.	4	4.5	0	0	0	0
			40 Hr. P.C.	5	5.0	0	0	3-5	0
11	18	3	Pre-Comp.	8	7.5	0	0	0	0
			Post-Comp.	4	5.5	1+	0	0	Gran.[1]
			40 Hr. P.C.	6	6.5	0	0	0	0
12	19	–	Pre-Comp.	6	5.5	1+	0	0-1	0
			Post-Comp.	4	6.5	2+	0	3-5	Gran.[2]
			40 Hr. P.C.	5	7.5	1+	0	2-4	0
13	20	2	Pre-Comp.	6	6.0	0	0	0	0
			Post-Comp.	6	6.0	1+	0	0	0
			40 Hr. P.C.	–	–	–	–	–	–
14	19	3	Pre-Comp.	8	7.0	0	0	0-2	0
			Post-Comp.	4	5.0	1+	0	0	Gran.[2]
			40 Hr. P.C.	–	–	–	–	–	–
15	21	3	Pre-Comp.	4	5.5	0	0	0	0
			Post-Comp.	4	4.5	0	0	0	0
			40 Hr. P.C.	7	7.5	0	0	0	0
16	21	4	Pre-Comp.	5	5.5	1+	0	0-2	0
			Post-Comp.	5	6.5	2+	0	0-3	0
			40 Hr. P.C.	7	7.5	1+	0	3-5	0

[1]Loaded with granular casts.
[2]Occasional granular cast.

contention of some authorities that this abnormality may not be related to the performance of strenuous exercise or trauma to the kidneys. Moreover, the absence of consistent findings in the post-exercise specimens of the wrestlers indicates that there was no injury to the kidneys as a result of amateur wrestling.

Conclusions

The study reported herein suggests that competition in amateur wrestling may be expected to produce in some contestants the following changes in the composition of the urine: increased acidity, the appearance of albumin, an increase in the number of casts, the appearance of red blood cells, and the appearance of sugar. Following a 40-hour post-competition period, these factors tended to return to pre-competition levels. None of the transient symptoms of renal trauma appeared with sufficient severity or duration to signify that permanent injury to the kidneys may result from wrestling conducted under intercollegiate or free-style rules.

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Use of Body Components as Reference Standards for Basal Metabolic Rate[1]

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Abstract

Thirty-seven variables, including those representing skeletal size, lean body mass, fat mass, water content, and total mass of the body, were measured in 100 male students 18-20 years old. The relationships of the above body components to basal oxygen intake showed weight, water-free mass, and lean body mass to be better reference standards than body surface area for the comparison of basal metabolic rates.

THE BASAL metabolic rate (BMR) has been used by numerous investigators to determine and interpret differences in levels of fitness (4, 16, 34) to predict physical performance (17) and to estimate other physiological functions (2, 18, 35). It has been investigated as to its relation to sex, age, climate, race, nutritional status, emotional tension, and many other variables (14).

The question, however, of a common basis for comparing the BMR's of different groups or individuals, has been (and still is) subject to much debate. It seems that the controversy is centered around two basic assumptions:

1. The basal metabolism is directly proportional to the amount of living tissue. Treviranus (21) tested this hypothesis in 1832 by measuring the CO_2 output of animals of different size and showed that the smaller species have an inversely proportional higher metabolism per unit of weight. He calculated that a mouse has a metabolism 385 times as high as a whale per gram of weight. Comparisons of metabolism of different sizes within a species were not made. Interest was soon diverted to the second assumption which gained great popularity.

2. The basal metabolism is directly proportional to the body heat loss, and the latter depends on the body surface area. Sarrus and Rameaux (31) suggested this already in 1839, but it was not before the turn of the century that Rubner (29, 30) brought it to the attention of investigators. He demonstrated the above relationship with measurements and concluded that the "heat production is determined by heat loss." Nearly all physiologists accepted this interpretation, and numerous derivations of the latter assumption are found in the literature. After Voit (36) in 1901 demonstrated that differences in basal metabolism between various species of homotherms tend to disappear when they are compared with units of surface area as reference

[1]This report is based on a Ph.D. dissertation written at the University of Illinois, Urbana, Illinois.

standard, Aub and DuBois (1) published standards of basal metabolism for humans and used surface area as a reference. The surface area was estimated by the DuBois and DuBois formula (10):

$$SA = W^{.425} \times H^{.725} \times 71.84$$

Harris and Benedict (13), basing their work on material obtained from 97 men, 97 women, and 61 children, arrived at the conclusion that the variation in basal metabolism per square meter of body surface was too large to warrant use of surface area as the common reference standard. They proceeded to reinvestigate the older assumption that the level of basal metabolism is determined by the "active mass of protoplasm" and proposed the use of their own formula, which was based on height, weight, and sex. Dreyer (9) included only weight and sex in a formula which he proposed. The latter formula has been used extensively in England. These standards for the basal metabolic rate have been superseded by the clinical standards of Boothby, Berkson, and Dunn (5), which are based on material from some 80,000 BMR determinations.

With different assumptions underlying the determination of a common reference standard, the variables which are common to nearly all proposed reference standards are sex, age, weight, and height. The latter two variables are used as measures of amount of living tissue at one time and as measures determining surface area another time, thus being used for both above-mentioned basic assumptions. Recently, however, some investigators have raised the question again as to the physiological meaning of these standards. Galvão (11) found that in tropical zones the heat production was not directly proportional to the body surface, but to the weight to a certain power:

$$\text{Heat production} = K\ \text{Weight}^{b}$$

K and b vary according to the constitution of the individuals (lean, medium, fat). In this interpretation of the results, he considered b as representative of "that part of the body weight that is metabolically active." Keys *et al.*, (14, *p. 307*), in their human starvation experiment, believed that calorie production per unit of surface area had no particular significance in understanding changes which take place in an individual. They conceded that the total metabolic exchange has significance, but pointed out that, with the recently developed techniques of body partitioning, it would be possible to determine the caloric production per unit mass of the different metabolizing tissues.

Behnke (3) proposed using "lean body mass" as means of predicting the basal metabolic rate. He pointed out that "age and sex differences in adults can be accounted for on the basis of variations of excess fat content, i.e., oxygen consumption per kilogram of lean body mass is constant within limits." Miller and Blyth (19, 20) stated that the fat-free body mass, or "lean body mass" was to be considered proportional to the "active tissue mass," and that this body component was theoretically a more reasonable reference unit than total body weight for the expression of such factors as metabolism, nutritional requirements, and drug dosage. They cited two techniques for

estimating "lean body mass": (1) subtract the fat content (obtained from specific gravity) from total body weight, and (2) measure the urinary creatinine excretion, which is proportional to "muscle mass." However, lack of consistency of the daily creatinine excretion made the latter unreliable. They measured 78 male college students, aged 18 to 35, weighing 53.9 to 136.4 kilograms, and correlated the obtained basal oxygen consumption with surface area (.84), weight (.85), and "lean body mass" (.92). The latter three variables were not independent, however, as surface area correlated .79, and weight .82, with "lean body mass." A partial correlation procedure, in which "lean body mass" was partialed out, gave a correlation of .45 between basal oxygen consumption and surface area, and a correlation of .14 between basal oxygen consumption and weight. The authors concluded: "It is apparent that the surface area and weight may derive much of their validity as metabolic reference standards from their high degree of correlation with 'lean body mass.'"

Brozek and Grande (7), however, pointed out the danger of the assumption that "lean body mass" is an entity. They contend that "lean body mass" consists of many sub-components which differ greatly in their oxygen consumption per unit weight of the metabolizing tissue. They added the basal partial oxygen consumption figures of the brain, liver, heart, and kidneys and thus showed that these four organs together require 61.1 per cent of the total body oxygen consumption. Muscles require 25.6 per cent and the rest is the approximate oxygen requirement of fat and bone. They concluded that compartmentalization is a useful concept in the investigation of physiological functions, especially where changes take place (starvation, aging), but that the limitations should be borne in mind. They vigorously attacked the undiscriminating shift from an obtained statistical relationship to a physiological causal relationship.

Problem

From the above literature, it seemed that with the newer techniques for estimating body components (i.e., total body fat, total body water) *in vivo*, physiologically more meaningful reference standards for the basal metabolic rate could be developed. The idea of breaking down total basal oxygen consumption into partial oxygen consumption of components has developed recently and needs extensive research. Progress has been hampered by the difficulties encountered in dividing the body into components *in vivo*, and by the lack of techniques for measuring the metabolic need of such components.

The general purpose of the present study was to determine the existing relationships between basal oxygen consumption and a number of measurements and indices which have been mentioned at one time or another as indicative of the size of the basal metabolic rate. Furthermore it was desired to investigate the relative value of each measurement or combinations of measurements for use as a reference standard for the comparison of metabolic activity.

Procedure

One hundred 18- and 19-year-old male university students participated as subjects. None had visited a medical doctor for reasons of poor health in the three months prior to taking the test. The students were all volunteers who were enrolled in the University Physical Education Service Program. Participation in this program involved all freshmen and sophomores who were not medically excused. All subjects were able to swim reasonably well, and thus were not afraid to exhale maximally under water during the specific gravity test. The measurements and indices used in the present study were selected on the basis of their reputed validity as the best single measurements for the representation *in vivo* of the fat, bone, muscle, lean mass, waterfree tissue, and water components of the body. The sources in the literature from which the variables under discussion were selected are included in the description of the procedure of collecting the data. The selected variables are presented in Table 1.

TABLE 1
The 38 Variables

Item No.	Measurement	Item No.	Measurement
1.	Chin skin fold (with fat caliper)	20.	Shoulder width
2.	Upper back fold (ibid)	21.	Hip width
3.	Lower back fold (ibid)	22.	Elbow width
4.	Chest fold (ibid)	23.	Wrist width
5.	Abdomen fold (ibid)	24.	Knee width
6.	Waist fold (ibid)	25.	Ankle width
7.	Trochanter fold (ibid)	26.	Chest depth
8.	Lower thigh fold (ibid)	27.	Height
9.	Total fat folds (1-8 added)	28.	Arm span
10.	Forearm radius (radius corrected for skin and subcutaneous fat)	29.	Total bone (20-28 added)
		30.	Specific Gravity (immersion method)
11.	Upper arm radius (ibid)	31.	Per cent fat (from 30)
12.	Thigh radius (ibid)	32.	Lean body mass (35 minus 36)
13.	Calf radius (ibid)	33.	Per cent water (from 30)
14.	Total radii (10-13 added)	34.	Basal oxygen intake (closed circuit apparatus)
15.	Elbow flexor strength (Clarke Cable tensiometer strength test)	35.	Body weight
16.	Elbow extensor strength	36.	Total fat pounds (from 31)
17.	Knee flexor strength	37.	Water-free tissue (35 minus 33)
18.	Knee extensor strength		
19.	Total strength (15-18 added)	38.	Surface area (from 27 and 35)

The basal oxygen intake (Item 33) was obtained under basal conditions and after at least eight hours of sleep with a commercial machine of the closed-circuit type. Care was taken that the environmental conditions were standardized. The tests were taken in an air-conditioned room, where the temperature and relative humidity were held constant at 76 $\pm$ .5° F. and 40 $\pm$ 1.5 per cent, respectively.

The specific gravity (Item 30) was used as a basis from which several other variables were estimated. The procedure was as follows: The subject was weighed, and climbed into a "Hubbard Tank" which was filled with water of 98.6° ± .2° F. Keeping his head above the surface, the subject lay down in a prone position on a steel and canvas stretcher which was suspended from a hook of a spring scale, hung over the tank from a beam. After two deep breaths, the subject exhaled maximally and slowly lowered himself under the surface with his whole body against the canvas. The highest reading of 5 trials was taken as an indication of weight at maximum exhalation and recorded. The equipment was weighed under water immediately afterwards and subtracted from the weight of equipment plus subject under water. The water density at 98.6° ± 2° F. was .994. The residual air after maximal exhalation was considered to be constant at 1500 cc. (15). With these factors the specific gravity was computed according to the formula (15):

$$\text{Spec. Gr.} = \frac{\text{Wt.}}{\text{Wt.—Wt. under water—(residual air) (water density)}}$$

The per cent fat (Item 31) was estimated from specific gravity with the prediction equation of Rathburn and Pace (24):

$$\text{Per cent fat} = 100 \left[\frac{5.548}{\text{Sp. Gr.}} - 5.044\right]$$

From the estimated per cent fat, the total fat (Item 36) was obtained. Subtraction of the latter variable from weight resulted in the lean body mass (Item 32).

In addition to total body fat, the water percentage of the weight (Item 33) was estimated by using the formula, proposed by Osserman, *et al.*, in which specific gravity was again the independent variable (22):

$$\text{Per cent water} = 100 \left[4.317 - \frac{3.960}{\text{Sp. Gr.}}\right]$$

From the per cent water, it was possible to derive the water free tissue (Item 37) component by subtracting the weight of the water component from the body weight.

The anthropometric measurements included a series of fat measurements (Items 1-8) which were taken with calipers, using a jaw pressure just short of pain. The skinfolds measured were those previously recommended by Brozek and Keys (6) (upper back, chest, and abdomen), Reynolds (27) (waist, trochanter, and lower thigh), and Skerlj (33) (lower back, chin). From the many areas which these authors recommend, the mentioned sites were chosen on *a priori* grounds; namely, the representation of the total body fat on the basis of a single fat fold measure. Adding all the fat folds resulted in total fat folds (Item 9).

The estimation of the muscle component (Items 10-14) was made by measuring the circumference of the forearm, upper arm, thigh, and calf. The tape was pulled firmly over tensed muscles. Keys, *et al.* (14, *Chapter 7*), assumed that the cross-section of the measured limb formed a perfect circle at the site of the measurement. Thus, he was able to calculate the radius of this cross-section and subtract from this the thickness of the skin-plus-fat layer, which he obtained by X-ray. In the present study, the mean thickness of five skinfolds, obtained around the limb at the measured level, were subtracted from the limb radius. The resulting figure was the radius of the bone-plus-muscle cross-section of the limb.

Reynolds and Asakawa (28) found that the mean bone breadth, as obtained by X-rays on a sample of 100 adult men, was 39.4 mm. with a standard deviation of 3.02 mm. Keys (14, *Chapter 7*), considered the cross-sectional area of the femur and humerus as constant at 6.07 and 3.8 cm^2 respectively, and subtracted this from the thigh and upper arm cross-sectional area. He did this in order to obtain the lean tissue changes during starvation.

In the present study, no changes in lean tissue were investigated; therefore, a distinction between bone and muscle cross-sectional areas was unnecessary.

The high relationship of strength to muscle circumference led to the choice of another estimate of the muscle component: strength of the elbow and knee flexor and extensor groups (Items 15-19), as measured by the cable tensiometer method of Clarke (8).

Bone measurements (Item 20-29) were selected on their *a priori* validity for being indicative of general skeletal development. Stature, arm span, chest depth, bi-acromial and bi-iliac diameters have been used extensively for such purposes, as is shown in several summarizing studies (23, 32). Elbow, wrist, knee, and ankle width measurements were added on the assumption that they would indicate the relative size of the skeleton.

The surface area (Item 38) was estimated according to the formula of DuBois and DuBois (10).

A matrix of product-moment correlations involving all 37 variables and the criterion (measured basal oxygen intake) was built with the use of the electronic digital computer (ILLIAC) of the University of Illinois (Table 2). This matrix was used as a basis for the calculation by the ILLIAC of the multiple correlation between basal oxygen intake as dependent variable, and 30 selected independent variables. The other seven of the original 37 were totals of a series of measurements (Items 9, 14, 19, 29), or directly estimated from the same basic measurement (Items 31, 33, 36). On the suspicion that these variables showed high correlations due to a part-whole relationship, they were excluded from the calculation of the multiple correlation.

The standard partial regression coefficients (beta coefficients) were computed from the correlation matrix, and are shown in Table 3. The products of the correlations and the beta-weights serve as indices of the relative size of the contribution of each independent variable to the variance in basal oxygen intake (12).

Reliability coefficients (test-retest) were obtained, using 25 of the 100 subjects.

Results and Discussion

From the matrix of product-moment correlations (Table 2),[2] some general observations can be made.

Most of the correlations above .800 were between inherently related variables (i.e., all fat folds correlated highly); or between two variables which were derived from the same basic measurement (i.e., specific gravity is a basic measurement from which percentage fat and percentage water are derived), or between a total and one of its parts (i.e., height is part of total bone). The lowest correlations were found with ankle width (all below .600). This measure also gave the lowest reliability coefficient (.646).

Some patterns can be observed which are of considerable interest:

1. Total fat pounds correlates .798 with the total fat folds measure. Both variables were obtained by independent methods—specific gravity and skinfold measurements, respectively. Total fat pounds also correlates well (.546 for chest fold to .756 for upper back fold) with all other skinfold measurements.

2. The radius measurements, which are measurements corrected for fat and skin thickness, correlate .712 (for calf radius) to .833 (for total radii) with lean body mass which is obtained independently by the specific gravity method.

3. Strength measures correlate .427 to .727 among themselves. No other variable related well to these measures.

4. Total bone correlates .765 with surface area (which is estimated from height and weight) and .924 with height. Surface area correlates .737 with height.

5. Specific gravity correlates highly with most of the derived variables: —.998 with total fat pounds, —.857 with dry tissue. It correlates .724 and less with the fat fold measures.

6. Weight correlates .600 or higher with 22 other variables.

From the above results, it seems probable that the fat fold and radii measurements are representative of the relative size of the total body fat and lean body mass components. Validation on human cadavers has not been done as yet; eventually, however, this will be necessary.

The high relationships between strength and limb circumference, as indicated in a study by Tanner (35), were not found. It was also noted that some of the best performers in the weight-lifting class scored low on the Clarke cable tensiometer strength test. It seems that the relationship of strength to muscle size ought to be re-evaluated in the light of the dynamic or static nature of the strength test used (26).

The fact that total bone correlates highly with surface area is probably due to the involvement of height in the estimation of both variables. In surface

[2]Variable No. 37 has been discussed as water-free tissue in the text.

area, height and weight determine the entire score. For total bone, height and arm span measures contribute more than 35 per cent each to the total score. This part-whole relationship is probably the cause of the high relationship of arm span and height to total bone.

Specific gravity was used as the basis for calculation of per cent fat, lean body mass, per cent water, total fat pounds, and waterfree tissue. As would be expected, high correlations of this variable with its derivatives were obtained.

Weight is well correlated with so many variables as to make it lose its value as a measure for pin-pointing any particular relationship. In any study involving size of the body or its parts, a clearer picture of existing relationships will probably be obtained if the influence of weight is excluded by means of partial correlation or other techniques.

Basal oxygen intake correlates significantly at the 1 per cent level of confidence with all variables except knee flexion strength, and at the 5 per cent level of confidence with that variable. More information can be gained, however, by viewing the relative size of the contribution of each variable to the variance in basal oxygen intake. A straightforward indication of this contribution is given by the standard partial regression coefficients (beta weights, B) and the zero order correlation coefficients. The product of these coefficients gives us the best comparison of each variable's contribution to the variance in the dependent variable (12).

Those variables which were obtained by totaling (total fat folds, etc.) and those which were derived directly from specific gravity (per cent fat, etc.) showed such high correlation coefficients within each group as to raise suspicion of being spurious, and consequently were removed from the calculation of the multiple correlation coefficient. The zero order product-moment correlation, beta weights, and their products are presented in Table 3 in the order of size of the latter.

The multiple correlation coefficient R between the criterion and the 30 other variables was .832 ± .031. The coefficient of multiple determination, R^2, is therefore +.692. The latter coefficient indicates the proportion of the variance in basal oxygen intake that is dependent upon, or associated with, or predicted by the 30 variables combined. The corresponding coefficient of multiple non-determination is $K^2 = .308$. The sum of the products of the zero order correlation and the beta coefficient of all 30 variables was used as a check of the squared multiple correlation coefficient:

$$R^2 = B_{1,2}r_{1,2} + B_{1,3}r_{1,3} + B_{1,4}r_{1,4} + \dots\dots\dots\dots + B_{1,38}r_{1,38} = +.687$$

which was close to the obtained $R^2 = +.692$.

Inspection of the sizes of the products of the beta weights and the correlation coefficients (Table 3, Product Br)[3] discloses a grouping which could be

[3]From the original 37 variables, the following were deleted for reasons mentioned in the text: Total fat folds, total radii, total strength, total bone, per cent fat, per cent water, and total fat pounds.

TABLE 2

Matrix of Intercorrelations for All Variables

r ≥ .197 SIGNIFICANT AT 5% LEVEL ——— r ≥ .254 SIGNIFICANT AT 1% LEVEL

VARIABLE NO.	VARIABLE	1 Chin fold	2 Upper back fold	3 Lower back fold	4 Chest fold	5 Abdomen fold	6 Waist fold	7 Trochanter fold	8 Low thigh fold	9 Total fat folds	10 Forearm radius	11 Upper arm rad.	12 Thigh radius	13 Calf radius	14 Total radii	15 Elbow flexion	16 Elbow extension	17 Knee flexion
1	Chin fold	.954	782	667	698	726	740	624	621	821	229	212	455	145	325	120	165	275
2	Upper back fold	.782	981	749	618	832	752	665	637	867	455	391	641	355	544	335	344	295
3	Lower back fold	.667	749	949	566	813	704	741	735	880	268	194	487	219	362	188	239	195
4	Chest fold	.698	618	566	900	617	589	543	538	718	073	055	295	034	159	-014	103	230
5	Abdomen fold	.726	832	813	617	967	819	792	762	939	355	295	545	280	446	229	242	220
6	Waist fold	.740	752	704	589	819	940	732	620	888	393	321	536	297	466	234	234	197
7	Trochanter fold	.624	665	741	543	792	732	950	790	883	259	238	416	264	378	175	177	105
8	Low thigh fold	.621	637	735	538	762	620	790	751	829	177	214	361	261	312	067	116	072
9	Total fat folds	.821	867	880	718	939	888	883	829	982	338	290	550	285	450	210	243	219
10	Forearm radius	.229	455	268	073	355	393	259	177	338	969	829	760	661	898	652	565	334
11	Upperarm rad.	.212	391	194	055	295	321	238	214	290	829	895	681	667	884	608	520	279
12	Thigh radius	.455	641	487	295	545	536	416	361	550	760	681	947	680	907	560	457	360
13	Calf radius	.145	355	219	034	280	297	264	261	285	661	667	680	961	840	545	318	241
14	Total radii	.325	544	362	159	446	466	378	312	450	898	884	907	840	986	664	519	350
15	Elbow flexion	.120	335	188	-014	229	234	175	067	210	652	608	560	545	664	752	662	437
16	Elbow extension	.165	344	239	103	242	234	177	116	243	565	520	457	318	519	662	736	421
17	Knee flexion	.275	295	195	230	220	197	105	072	219	334	279	360	241	350	437	421	891
18	Knee extension	.229	355	155	088	257	271	187	109	245	387	393	444	374	461	568	436	492
19	Total strength	.279	421	248	143	304	292	213	126	297	554	525	557	440	592	759	711	727
20	Shoulder width	.094	170	112	066	152	143	056	082	129	365	365	454	441	461	254	322	184
21	Hip width	.332	388	393	251	358	315	256	358	380	244	250	382	381	362	185	126	263
22	Elbow width	.201	340	298	090	310	250	166	245	280	524	492	508	467	558	370	334	202
23	Wrist width	.127	186	120	-020	056	115	-050	-082	063	506	506	400	400	498	383	419	240
24	Knee width	.398	433	411	300	396	462	292	269	433	325	302	484	446	452	236	219	326
25	Ankle width	.113	116	150	-018	057	096	013	-003	077	246	222	228	270	268	185	273	227
26	Chest depth	.538	687	553	433	618	635	463	442	619	545	534	684	547	673	474	375	353
27	Height	.204	194	151	122	174	254	065	113	184	242	232	360	339	341	178	162	293
28	Arm span	.213	170	098	088	174	177	088	138	161	267	315	381	367	384	169	173	198
29	Total bone	.299	293	224	175	280	311	160	209	280	339	356	467	435	461	249	230	278
30	Specific grav.	-.616	-663	-685	-501	-676	-702	-604	-618	-742	-207	-762	-438	-283	-331	-778	-153	-215
31	Percent fat	.631	673	702	511	685	707	611	634	753	195	154	432	271	321	177	155	218
32	Lean body mass	.304	430	270	187	400	432	310	246	387	746	728	750	712	833	510	418	380
33	Percent water	-.606	-671	-694	-498	-675	-695	-606	-617	-742	-218	-171	-452	-300	-346	-178	-160	-225
34	Basal ox. intake	.362	489	351	270	424	420	302	361	432	533	514	682	474	634	364	311	233
35	Weight	.587	718	595	433	686	710	560	544	711	701	671	834	711	839	500	419	408
36	Total fat lbs.	.677	756	734	546	736	740	622	672	798	333	303	566	393	474	265	222	261
37	Dry tissue	.684	801	733	532	776	785	650	655	822	533	492	738	573	682	387	343	361
38	Surface area	.441	485	354	324	459	521	329	349	475	499	479	619	570	621	299	219	373

□ : RELIABILITY COEFFICIENTS

TABLE 2

Matrix of Intercorrelations for All Variables

18 Knee extension	19 Total strength	20 Shoulder width	21 Hip width	22 Elbow width	23 Wrist width	24 Knee width	25 Ankle width	26 Chest depth	27 Height	28 Arm span	29 Total bone	30 Specific grav.	31 Percent fat	32 Lean body mass	33 Percent water	34 Basal ox. intake	35 Weight	36 Total fat lbs.	37 Dry tissue	38 Surface area
.229	.279	094	332	201	127	398	113	538	204	213	299	-616	631	304	-606	362	587	677	684	441
.355	.421	170	388	340	186	433	116	687	194	170	293	-663	673	430	-671	489	718	756	801	485
.155	.248	112	393	298	120	411	150	553	151	098	224	-685	702	270	-694	351	595	734	733	354
.088	.143	066	251	090	-020	300	-018	433	122	088	175	-501	511	187	-498	270	433	546	532	324
.257	.304	152	358	310	056	396	057	618	174	174	280	-676	685	400	-675	424	686	736	776	459
.271	.292	143	315	250	115	462	096	635	254	177	311	-702	707	432	-695	420	710	740	785	521
.187	.213	056	256	166	-050	292	013	463	065	088	160	-604	611	310	-606	302	560	622	650	329
.109	.126	082	358	245	-082	269	-003	442	113	138	209	-618	634	246	-617	361	544	672	655	349
.245	.297	129	380	280	063	433	077	639	184	161	280	-742	753	387	-742	432	711	798	822	475
.387	.554	365	244	524	506	325	246	545	242	267	339	-207	195	746	-218	533	701	333	533	499
.393	.525	365	250	492	506	302	222	534	232	315	356	-162	154	728	-171	514	671	303	492	479
.444	.557	454	382	508	400	484	228	684	360	381	467	-438	432	750	-452	682	834	566	738	619
.374	.440	441	381	467	400	446	270	547	339	367	435	-283	271	712	-300	474	711	393	573	570
.461	.592	461	362	558	498	452	268	673	341	384	461	-331	321	833	-346	634	839	474	682	621
.568	.759	254	185	370	383	236	185	474	178	169	249	-178	177	510	-178	364	500	265	387	299
.436	.711	322	126	334	419	219	273	375	162	173	230	-153	155	428	-160	311	419	222	343	219
.492	.727	184	263	202	240	325	227	353	293	198	278	-215	218	380	-225	233	408	261	361	373
$\boxed{.920}$	880	262	197	361	294	345	238	429	272	300	337	-159	162	450	-167	401	486	316	393	407
.880	$\boxed{.947}$	307	253	385	384	353	283	517	305	297	364	-208	211	552	-217	442	571	341	464	439
.262	.307	$\boxed{918}$	473	539	469	461	333	264	558	585	664	-169	170	542	-168	429	517	256	400	522
.197	.253	473	$\boxed{985}$	547	317	536	444	370	633	634	720	-510	520	432	-512	412	616	571	633	582
.361	.385	539	547	$\boxed{919}$	626	567	512	485	520	562	646	-310	301	594	-308	517	639	411	549	548
.294	.384	469	317	626	$\boxed{900}$	519	548	325	517	556	593	-094	091	576	-092	286	473	135	331	418
.345	.353	461	536	567	519	$\boxed{972}$	584	520	618	580	680	-495	497	534	-500	475	668	537	651	634
.238	.283	333	444	512	548	584	$\boxed{646}$	199	494	518	544	-234	230	342	-235	304	386	269	352	374
.429	.517	264	370	485	325	520	199	$\boxed{969}$	362	318	475	-574	579	603	-566	607	781	655	766	618
.292	.305	558	633	520	517	618	494	362	$\boxed{995}$	852	924	-322	321	574	-320	493	580	329	497	737
.300	.297	585	634	562	556	580	518	318	852	$\boxed{980}$	937	-305	299	552	-302	470	568	336	482	658
.337	.364	664	720	646	593	680	544	475	924	937	$\boxed{994}$	-411	409	633	-382	571	689	452	601	765
-.159	-.208	-169	-510	-310	-094	-495	-234	-574	-322	-305	-411	$\boxed{960}$	-998	144	987	-381	-613	-924	-857	-468
.162	.211	170	520	301	091	497	230	579	321	299	409	-998	$\boxed{981}$	141	-985	384	614	927	859	465
.450	.552	542	432	594	576	534	342	603	574	552	633	-144	141	$\boxed{994}$	-156	621	845	276	592	716
-.167	-.217	-168	-512	-308	-092	-500	-235	-566	-320	-302	-382	987	-985	-156	$\boxed{964}$	-367	-618	-916	-867	-466
.401	.442	429	412	517	286	475	304	607	493	470	571	-381	384	621	-367	$\boxed{925}$	714	512	617	622
.486	.571	517	616	639	473	668	386	781	580	568	689	-613	614	845	-618	714	$\boxed{999}$	748	922	831
.316	.341	256	571	411	135	537	269	655	329	336	452	-924	927	276	-916	512	748	$\boxed{993}$	922	604
.393	.464	400	633	549	331	653	352	766	497	483	601	-857	859	592	-867	617	922	922	$\boxed{992}$	740
.407	.439	522	582	548	418	634	374	618	737	658	765	-468	465	716	-466	622	831	604	740	$\boxed{994}$

TABLE 3

Relationships of Oxygen Intake to 30 Other Variables

Variable Number	Description	Correlation r	Beta B	Product Br	Rank
35	Weight	.714	+2.400	+1.714	1
37	Water free tissue	.617	−2.058	−1.270	2
32	Lean body mass	.621	− .463	− .288	3
30	Specific gravity	−.381	− .605	+ .231	4
12	Thigh radius	.682	+ .327	+ .223	5
27	Height	.493	+ .327	+ .161	6
13	Calf radius	.474	− .220	− .104	7
26	Chest	.607	+ .163	+ .099	8
6	Waist fold	.420	− .227	− .095	9
2	Upper back fold	.489	+ .189	+ .092	10
23	Wrist width	.286	− .304	− .087	11
38	Surface area	.622	− .110	− .068	12
21	Hip width	.412	− .128	− .053	13
8	Low thigh fold	.361	+ .157	+ .050	14
10	Forearm radius	.533	+ .086	+ .046	15
18	Knee extension	.401	+ .104	+ .042	16
7	Trochanter fold	.302	− .135	− .041	17
11	Upper arm radius	.514	+ .079	+ .041	18
25	Ankle width	.304	+ .120	+ .036	19
5	Abdomen fold	.424	− .085	− .036	20
17	Knee flexion	.233	− .144	− .034	21
22	Elbow width	.517	+ .063	+ .033	22
15	Elbow flexion	.364	− .080	− .029	23
28	Arm span	.470	− .047	− .022	24
20	Shoulder width	.429	+ .042	+ .018	25
24	Knee width	.475	+ .037	+ .018	26
1	Chin fold	.362	− .035	− .013	27
4	Chest fold	.270	+ .037	+ .010	28
3	Lower back fold	.351	+ .025	+ .009	29
16	Elbow extension	.311	+ .012	+ .004	30

classified arbitrarily as highly significant (Rank 1 and 2), significant but far below the highly significant products (Rank 3 through 6), and not significant (Rank 7 through 30).

In relationship to basal oxygen intake, weight (Br + 1.714) and water-free tissue (Br — 1.270) topped the scale in their relative importance as factors in the determination of the basal oxygen intake. Lean body mass (Br — .288), specific gravity (Br. + .231), thigh radius (Br + .223), and height (Br + .161) are next in size and considerably higher in their influence on basal oxygen intake than surface area (Br — .068) which is 12th in order of contribution.

From the above results, some general information was derived: Weight alone would be considerably better reference standards for the basal metabolic rate, than surface area which is estimated from height and weight by the DuBois and DuBois formula (10).

It seems that this formula has validity for obtaining the estimated surface area, but that surface area as such, with the influence of other variables removed or held constant, has little to do with basal oxygen intake. It is possible that estimated surface area has shown validity as a reference standard simply because of its representativeness of other variables, whose influence were partialed out in the present study. Indications from the above results are that estimated surface area represents body bulk and so obtains its importance as a reference standard, without having physiological meaning in relation to basal metabolism.

Water-free tissue ranks high as a possible reference standard for basal metabolic rate, a fact which is understandable as the metabolically inert total body water (averaging 63.17 $\pm$ 4.52 per cent of body weight) is excluded from this estimate. This procedure leaves water-free tissue, which theoretically ought to be directly related to basal oxygen intake, as it represents the amount of metabolicallly active tissue. The fact that weight is higher on the list could point towards the relative unreliability of derived estimates as compared to raw measures.

Specific gravity is fourth in order of size of contribution to the variance in basal oxygen intake. This measure is considered an index of over-all density of the body. Density, however, is for the major part determined by the relative amount of total fat. The latter component has been considered to be metabolically inert, and a removal of its influence in the raw data (resulting in the fat-free or lean body mass), shows an increase in contribution to the variance in basal oxygen intake, placing lean body mass third in rank. While accounting for only a small part of the total oxygen requirements during exercise, fatty tissue is not completely inert metabolically and may even require a significant percentage of the basal oxygen intake. This would account for the much higher contributions made by weight and water-free tissue, which include the fat component. Thigh radius, which is a variable corrected for fat, is highly correlated with the independently obtained lean body mass (.750), and fifth in the order of size of contribution. This, again, indicates the relative importance of fat-free tissue as the metabolic reference standard.

Height, ranking sixth in the order of size of contribution to basal oxygen intake, can be considered a measure of body size. In view of the fact that size or bulk seems to contribute considerably, it is understandable that this variable ranks so high. The rest of the variables are comparatively low in their contribution.

Age and sex were excluded as factors at the beginning of the present study by the use of a sample restricted to males age 18 to 20. It would be advisable to investigate the influence of the sex and age factors before establishing permanent reference standards.

Summary and Conclusions

One hundred male university students, 18 to 20 years of age, were measured as to basal oxygen intake. They were also tested on 37 variables that included representation of the bone, fat, water, fat-free tissue, and water-free tissue components.

The relationships of basal oxygen intake to the represented body components were analyzed with the use of the standard partial regression coefficients (beta weights). These coefficients were obtained as a part of the procedure intake as the dependent variable and 30 independent variables.

Based on the results of this study, the following conclusions can be drawn.

1. For the purpose of comparing basal metabolic rates of different groups or individuals, or of the same individual, a reference standard consisting of total body weight and/or water-free tissue weight would deserve preference.

2. Lean body mass, specific gravity, thigh radius, and height contribute sufficiently to the variance in basal oxygen intake to warrant inclusion in the reference standard.

3. Surface area is not directly related to basal oxygen intake in a physiological way, but only indirectly as an estimate of body bulk. For the purpose of comparing changes in basal oxygen intake within the individual, surface area is inadequate as it does not take changes in body components into account.

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Effect of Repetition Upon Speed of Preferred-Arm Extension

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Abstract

The purpose of this study was to determine the effect of repetition upon the speed of a simple body movement. Male college students were timed on repeated trials of the preferred-arm extension movement. The timing device utilized a chronoscope which measured the interval from the releasing of a micro-switch to the interrupting of a light beam striking a phote-electric cell. In all subjects, repeated trials resulted in faster movement times. Fifty trials produced faster movements than did 20 trials. All subjects exhibited considerable variation in successive trials for the preferred-arm extension movement.

CONFLICTING evidence has been presented in the literature concerning the effects of various types of warm-up on physical performance. Karpovich and Hale (7), in experiments on varsity track performers at Springfield College, concluded that deep massage, digital stroking, and preliminary exercises did not significantly improve the time for running the 440-yard dash. They also indicated that preliminary exercises did not significantly improve spring performances on the bicycle ergometer. Hipple (4) found that preliminary running had no effect on the time required to run the 50 yard dash.

Asmussen and Bøje (1) studied the effect of preliminary work, short wave diathermy, hot shower bath, and massage upon the performance on the bicycle ergometer. All methods were beneficial, except massage, in the performance of both sprint and endurance rides. Schmid, as cited by Karpovich and Hale, (7), reported that all the methods of warm-up utilized by Asmussen and Bøje, including massage, improved the performance of both men and women in swimming 50 meters, running 100 meters and riding the bicycle ergometer.

It appeared from the studies cited that additional work needed to be done on various aspects of physical performance in relation to warm-up. Most of the previous studies have been concerned with complex movements such as running, swimming, or riding the bicycle. No literature seemed to be available on the effects of repetition as a form of warm-up affecting physical performance. It appeared that repetition should be included as a form of warm-up and for the purposes of this study it was considered as such.

In light of Watkins study (11) on arm and leg flexion, extension, and abduction, which indicated that preferred-arm extension is the fastest of the 12 movements tested; it was determined that preferred-arm extension would be the simple movement tested in this investigation. This study was conducted to determine the effects of repetition upon the speed of preferred-arm extension.

Definition of Terms

Repetition. For the purposes of this study, any test trial was considered a repetition and, hence, a contribution to warm-up for successive trials.
Speed of movement. The period of time, measured in thousandths of a second, which elapsed from the releasing of a micro-switch by the initiation of movement to the interrupting of a beam of light on a photo-electric cell 20 inches distant in the direct path of the moving limb (9).
Extension. A movement which brings the member of a limb into or toward a straight condition.

Testing Procedures

In the experiment, a total of 30 subjects were used. Two phases of the experiment were conducted. The first involved testing 19 subjects on 20 repetitions of the speed of movement for preferred-arm extension. The second phase consisted of testing 11 subjects on 50 repetitions of the preferred-arm extension movement. Separate analyses of data were made for each phase of the study.

Subjects in the study consisted of 22 male students in the required physical education program at Pennsylvania State University and 8 male graduate students. The subjects ranged in age from 18 years to 28 years, with a mean age of 21.4 years.

The apparatus used for testing the subjects consisted of a Barn-Wat meter[1], a chronoscope for timing movement to the nearest thousandth of a second, a hot-shot battery for producing the necessary current for operation of the chronoscope, and a circuit-breaking relay. The Barn-Wat meter, shown in Figure I, included a microswitch on one wing for actuating the circuit, and a photo-electric cell on the other wing for breaking the circuit. The chronoscope recorded the time which elapsed from the releasing of the microswitch, thus actuating the circuit, to the interrupting of the light beam striking the photo-electric cell. The reliability of the speed of movement device was determined by running 100 time trials with a freely-falling metal sphere. An electromagnet was wired to the top of the apparatus so that the microswitch would be actuated and the clock started simultaneously with the releasing of the metal sphere. The freely-falling object will always fall at the same rate, thus making it possible to measure the time interval from the releasing of the microswitch to the interrupting of the light beam and hence

[1]Devised by Donald J. Watkins for a Master's thesis at Pennsylvania State University.

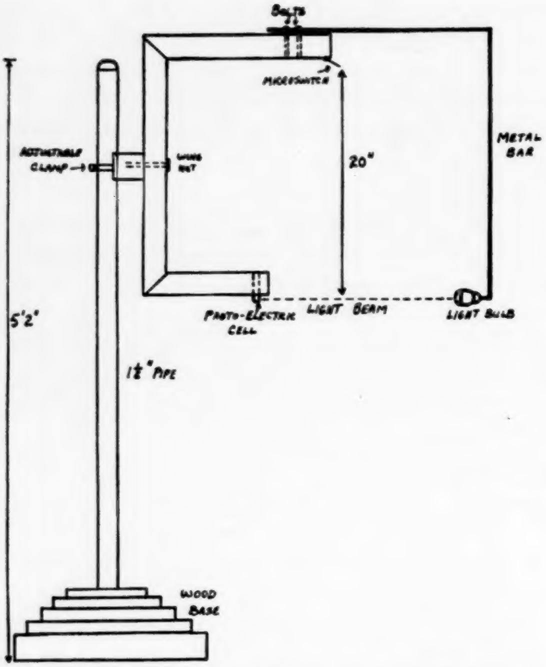

FIGURE I. Barn-Wat Meter for Determining Speed of Movement

stopping the chronoscope. Using the data for the 100 time trials, it was found that the error would not exceed ±1.2 per cent.

In testing the preferred-arm extension movement the following procedures, shown in Figure II, were observed:

(a) The subject faced the meter with feet spread comfortably, free arm at the side, head up, and with the back straight.

(b) The micro-switch was depressed with the tip of the middle finger of the preferred-arm.

(c) The preferred arm was placed at an angle of 65° at the elbow with the palm of the hand up (supinated). The elbow angle of 65° was determined each time with a goniometer.

(d) When the tester indicated he was ready, the subject, at his own discretion, extended the elbow by throwing the back of the hand toward the floor and keeping the elbow in a constant position.

Prior to testing each subject in the study, the movement to be tested was demonstrated by the tester. The subject was then permitted to take several practice trials with the non-preferred arm. The subject was not told how

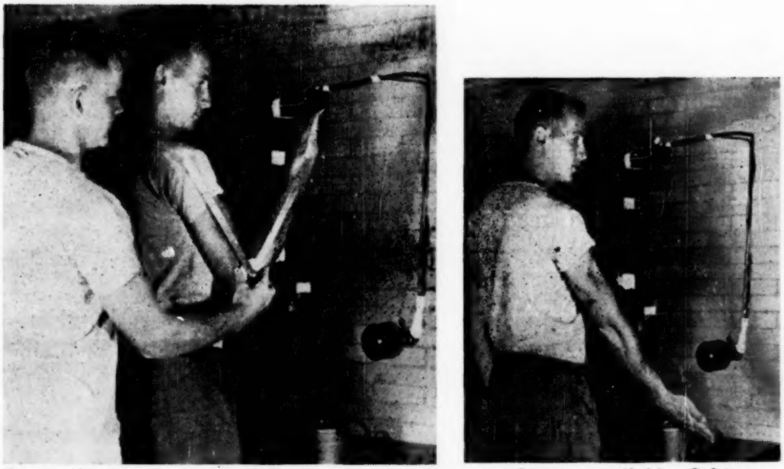

FIGURE II. Subject Prepared To Execute Arm-Extension Movement (*left*); Subject at Completion of Arm-Extension Movement (*right*).

many test trials would be run, but he was urged to exert his maximum effort on each trial. After completion of each trial, the subject resumed the starting position for testing so that the arm angle at the elbow could be checked before the next trial. Approximately ten seconds elapsed between each two trials. The subject initiated each movement trial at his own convenience, after the arm angle was checked; hence, reaction time was completely absent from consideration in the measurements of the study.

All testing in the study was conducted at approximately the same time of day to insure constant conditions for all subjects. No attempt was made to control the motivation of the subjects other than to urge each to do his best on each trial.

Analysis of Data

FIRST TESTING PHASE

Table 1 indicates that each subject demonstrated considerable variation among test trials on the preferred-arm extension movement. In the first phase of the study involving 19 subjects tested for 20 trials, the mean for all trials for all subjects was .108 seconds. The average range for these 19 subjects was .056 seconds. The mean difference between successive trials trials for all 19 subjects on the 20 trials was .011. The mean difference between successive trials was calculated by taking the difference between each two successive readings for all 20 trials for all the subjects. The average range was determined by subtracting the lowest from the highest movement time for each subject and averaging these ranges for all subjects.

For purposes of analysis, the mean of each group of five trials was compared with each succeeding group of five repetitions. Because of the indi-

TABLE 1

Data on Variation of the Individuals in the Two Groups of Subjects Tested on the Preferred-Arm Extension Movement

Test	N	n	M*	Mean Difference in All Trials	Average Range for All Subjects
First Testing Phase	19	380	.108	.011	.056
Second Testing Phase	11	550	.092	.009	.051

*Expressed in seconds.

vidual variations from trial to trial, it was felt that the mean of each group of five trials would be more reliable for comparative purposes than merely using each individual trial.

Table 2 shows that the group means were reduced through repeated trials. Table 3 shows that the mean of repetitions 1-5 was significantly faster than the means of trials 11-15 and trials 16-20. None of the groups beyond the the first group demonstrated significant gains over its successive groups, although means were reduced through repetition.

Figure III portrays graphically the means for each individual trial. The first trial had the highest mean, while the ninth trial had the lowest mean. Although variations were present from trial to trial, the trend was toward faster movements as more repetitions occurred.

SECOND TESTING PHASE

Table 1 indicates that the 11 subjects tested on 50 trials were somewhat more consistent in their over-all trials, as demonstrated by their lower mean difference in all trials and also a slightly reduced mean range, and also had a lower mean than did the 19 subjects tested on only 20 trials.

Tables 2 and 4 and Figure III reveal the same general trends for 50 repetitions as for 20 trials, although the effects of repeated trials are more pronounced. In Table 4, it is seen that the group including trials 1-5 was significantly faster than all but two of the successive groups of five trials. The critical ratios tended to become more significant as a greater number of trials was given. It is shown in Figure III that the 47th trial was the fastest in the group of 50 repetitions.

Summary

The purpose of this study was to determine the effect of repetition upon the speed of a simple body movement. Two groups of subjects were used in the study. The first group consisted of 19 subjects who were given a total of 20 trials in the preferred-arm extension movement. The second group consisted of 11 subjects who were given 50 trials in the same movement.

TABLE 2

Data for the Various Groups of Five Repetitions

Test		Repetition Groups (Time expressed in seconds)									
		1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50
First Testing Phase	M	.116	.107	.105	.104						
N = 19	σ_m	.0035	.0034	.0026	.0025						
Second Testing Phase	M	.099	.091	.093	.094	.095	.092	.091	.090	.089	.087
N = 11	σ_m	.0022	.0026	.0019	.0018	.0016	.0018	.0022	.0021	.0022	.0027

TABLE 3

Critical Ratios for the Comparison of Each Group of Five Trials with Each Successive Group of Five Trials for 19 Subjects Executing 20 Repetitions of the Preferred-Arm Extension Movement (Phase I Only)

Groups of Repetitions	Groups of Repetitions		
	1-5	6-10	11-15
1-5	———	———	———
6-10	1.84	———	———
11-15	2.50*	.47	———
16-20	2.79**	.71	.28

*Significant at 5% level.
**Significant at 1% level.

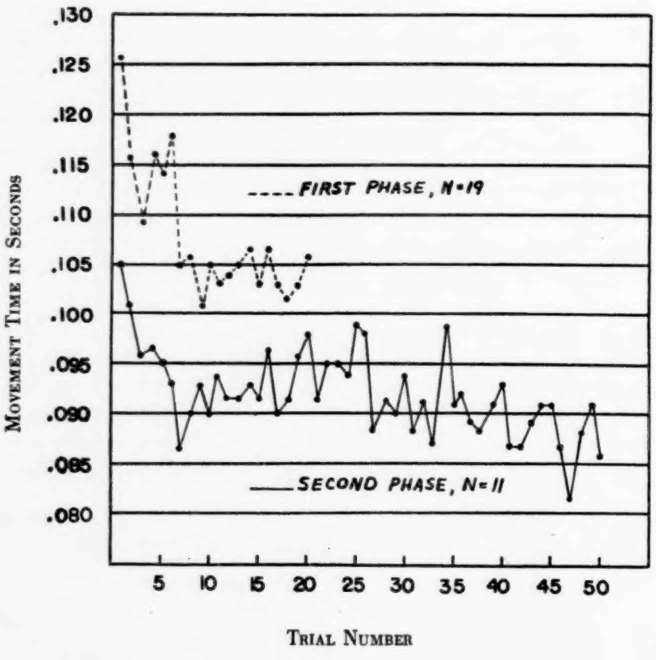

FIGURE III. Means for Each Individual Trial on the Preferred-Arm Extension Movement

TABLE 4

Critical Ratios for the Comparison of Each Group of Five Trials with Each Successive Group of Five Trials for 19 Subjects Executing 20 Repetitions of the Preferred-Arm Extension Movement (Phase II Only)

Groups of Repetition	Groups of Repetitions								
	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45
1-5									
6-10	2.35*								
11-15	2.07*	.62							
16-20	1.79	.94	.38						
21-25	.74	1.29	.80	.42					
26-30	2.50*	.31	.38	.80	1.25				
31-35	2.58**	.00	.69	1.07	1.48	.36			
36-40	3.00**	.31	1.07	1.43	1.92	.71	.33		
41-45	3.23**	.59	1.38	1.79	2.22*	1.07	.65	.33	
46-50	3.87**	1.05	1.82	2.19*	2.58**	1.56	1.14	.88	.57

*Significant at 5% level.
**Significant at 1% level.

All subjects were selected at random from the required physical education program at Pennsylvania State University. Subjects were not informed as to the number of trials to be taken and all testing was done at approximately the same time of day.

Testing was done on a specially constructed device which utilized a microswitch, a photo-electric cell, and a chronoscope for measuring time to the nearest thousandth of a second.

The data were analyzed to show the variations in times for successive trials and for successive groups of five repetitions each to determine whether repetition of the arm-extension movement resulted in faster times. Separate analyses were made for the groups having 20 and 50 trials, respectively.

Conclusions

1. It would appear that individuals vary considerably in successive repetitions of the simple movement of preferred-arm extension.

2. Repetition, as a form of warm-up, tended to produce faster movement times on a simple arm movement.

3. The more trials that were given the more significant became the differences in the means. Fifty trials resulted in faster movements than did 20 trials.

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(Submitted 9/16/57)

Study of Personality Variables Among Successful Women Students and Teachers of Physical Education [1]

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Abstract

The purpose of this study was to determine whether or not a pattern of similarity of personality variables existed among successful women undergraduate students, graduate students, and teachers in physical education and to compare the total physical education administered to 100 teachers, 55 graduate students, and 100 senior majors who were suggested by administrators in selected schools of professional preparation. The physical education groups showed a similarity of patterns, and significant differences were found when the total physical education group was compared with the normative group.

NUMEROUS studies have shown that personality has a close relationship to quality of teaching (12). Because there are definitely measurable relationships between personality and vocational interest, personality inventories should be included in a guidance testing program; however researchers must first derive profiles of personality patterns peculiar to various occupations and establish the *means* of specific occupations with regard to personality factors (6).

Purpose of the Study

The purpose of this study was to determine whether or not there was an existing pattern of similarity of personality variables among successful women undergraduate students, graduate students, and teachers in physical education and to compare the total physical education group with a normative group.

Definition of Terms

PERSONALITY

Personality is the dynamic integration of an individual's expression of his needs in his reactions to himself and others (4), (10).

PERSONALITY VARIABLES

A personality variable is a factor of personality which is constantly developing and changing (8). The variables used in this study were the following as described by Edwards (2):

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[1]This study was made in partial fulfillment of the requirements for the degree Master of Education, at the Woman's College of the University of North Carolina, Greensboro, under the direction of Dr. Gail Hennis.

Achievement: To do one's best, to be successful, to accomplish tasks requiring skill and effort, to be a recognized authority, to accomplish something of great significance, to do a difficult job well, to solve difficult problems and puzzles, to be able to do things better than others, to write a great novel or play.

Deference: To get suggestions from others, to find out what others think, to follow instructions and do what is expected, to praise others, to tell others that they have done a good job, to accept the leadership of others, to read about great men, to conform to custom and avoid the unconventional, to let others make decisions.

Order: To have written work neat and organized, to make plans before starting on a difficult task, to have things organized, to keep things neat and orderly, to make advance plans when taking a trip, to organize details of work, to keep letters and files according to some system, to have meals organized and a definite time for eating, to have things arranged so that they run smoothly without change.

Exhibition: To say witty and clever things, to tell amusing jokes and stories, to talk about personal adventures and experiences, to have others notice and comment upon one's appearance, to say things just to see what effect it will have on others, to talk about personal achievements, to be the center of attention, to use words that others do not know the meaning of, to ask questions others cannot answer.

Autonomy: To be able to come and go as desired, to say what one thinks about things, to be independent of others in making decisions, to feel free to do what one wants to do, to do things that are unconventional, to avoid situations where one is expected to conform, to do things without regard to what others may think, to criticize those in positions of authority, to avoid responsibilities and obligations.

Affiliation: To be loyal to friends, to participate in friendly groups, to do things for friends, to form new friendships, to make as many friends as possible, to share things with friends, to do things with friends rather than alone, to form strong attachments, to write letters to friends.

Intraception: To analyze one's motives and feelings, to observe others, to undertand how others feel about problems, to put one's self in another's place, to judge people by why they do things rather than by what they do, to analyze the behavior of others, to analyze the motives of others, to predict how others will act.

Succorance: To have others provide help when in trouble, to seek encouragement from others, to have others be kindly, to have others be sympathetic and understanding about personal problems, to receive a great deal of affection from others, to have others do favors cheerfully, to be helped by others when depressed, to have others feel sorry when one is sick, to have a fuss made over one when hurt.

Dominance: To argue for one's point of view, to be a leader in groups to which one belongs, to be regarded by others as a leader, to be elected or appointed chairman of committees, to make group decisions, to settle arguments and disputes between others, to persuade and influence others to do what one wants, to supervise and direct the actions of others, to tell others how to do their jobs.

Abasement: To feel guilty when one does something wrong, to accept blame when things do not go right, to feel that personal pain and misery suffered do more good than harm, to feel the need for punishment for wrong doing, to feel better when giving in and avoiding a fight than when having one's own way, to feel the need for confession of errors, to feel depressed by inability to handle situations, to feel timid in the presence of superiors, to feel inferior to others in most respect

Nurturance: To help friends when they are in trouble, to assist others less fortunate, to treat others with kindness and sympathy, to forgive others, to do small favors for others, to be generous with others, to sympathize with others who are hurt or sick, to show a great deal of affection toward others, to have others confide in one about personal problems.

Change: To do new and different things, to travel, to meet new people, to experience novelty and change in daily routine, to experiment and try new things, to eat

in new and different places, to try new and different jobs, to move about the country and live in different places, to participate in new fads and fashions.

Endurance: To keep at a job until it is finished, to complete any job undertaken, to work hard at a task, to keep at a puzzle or problem until it is solved, to work at a single job before taking on others, to stay up late working in order to get a job done, to put in long hours of work without distraction, to stick at a problem even though it may seem as if no progress is being made, to avoid being interrupted while at work.

Heterosexuality: To go out with members of the opposite sex, to engage in social activities with the opposite sex, to be in love with someone of the opposite sex, to kiss those of the opposite sex, to be regarded as physically attractive by those of the opposite sex, to participate in discussions about sex, to read books and plays involving sex, to listen to or tell jokes involving sex, to become sexually excited.

Aggression: To attack contrary points of view, to tell others what one thinks about them, to criticize others publicly, to make fun of others, to tell others off when disagreeing with them, to get revenge for insults, to become angry, to blame others when things go wrong, to read newspaper accounts of violence.

SUCCESS

Success was determined on the basis of the possession of emotional maturity, extensive knowledge of subject matter, good health, a pleasing personal appearance, enthusiasm for work, and a good sense of humor.[2]

Related Research

Studies of the personality of persons in phyiscal education have been done by Duggan (1), Hein (5), Palmer (9), Freeman (3), Mochel (7), and Sperling (11); however, no recent attempts have been made to describe specifically the personality of a large group of successful persons in the field. The Edwards Personal Preference Schedule is a new personality inventory, which as yet has not been used by physical educators.

Procedure

Twenty administrators in selected departments of professional preparation throughout the United States suggested subjects whom they considered to be successful. The administrators had previously been encouraged to use the following criteria as a basis for their suggestions: emotional maturity, extensive knowledge of subject matter, good health, a pleasing personal appearance, enthusiam for work, and a good sense of humor. From the persons suggested, 100 teachers, 55 graduate students, and 100 senior majors completed and returned the Edwards Preference Schedule by the date set and were included in this study.[3]

The Edwards test was chosen because it measures manifestations of normal needs (this is desirable when a test is to be used for guidance and the subject is to learn the scores made); it is a recent test; it has statistically

[2] The qualities chosen as the criteria for success were selected after reviewing the research which had been done in that area by persons in education, physical education, psychology, and vocational guidance.

[3] Senior majors composed the undergraduate group, and the graduate students were currently enrolled in graduate schools and colleges. All of the teachers were active in the profession.

sound construction; and it measures a large number of factors. There is a check for consistency in taking the test, which is also a desirable factor.

In analyzing the data, each group was studied separately and then an inter-comparison was made of the three groups — teachers with graduate students, teachers with senior majors, and graduate students with senior majors. Each of the three groups was also compared with the normative group[4] of the Edwards test. In addition, a comparison was made of the total physical education group with the normative group.

Analysis of Data

The t-test for significance of difference between means was used to compare all groups. No differences were considered significant if the t was above the 5 per cent level of confidence, and most of the significant differences were evidenced at the 1 per cent, better than 1 per cent, and better than .1 per cent levels of confidence.

Table 1 gives the mean and standard deviation for each group on the 15 variables and the consistency score, and Table 2 gives the t's for the differences between means of the groups.

It may be noted that, although there were significant differences between the physical education groups, these differences were not as numerous as the differences between the physical education groups and the normative group. It may be noted also that graduate students were often an erratic group.

Summary of Findings

On the *deference* variable, the total physical education group was significantly higher than the normative group. Deference increased with the increased age of groups. When teachers were compared with seniors, there was a significant difference. All of the physical education groups were higher than the normative group on this variable, and graduate students and teachers were significantly higher.

On the *order* variable, the total group was significantly higher than the norm, and scores increased with the age of the group. There was a significant difference between the teachers and graduates on this factor. All of the physical education groups were higher than the norm; however, the teacher group was the only one significantly higher.

Although the graduate students and seniors were higher than the norm in *exhibition*, the teachers were significantly lower. When groups were combined, the resulting mean was lower than the norm, but this difference was not significant. The teachers were also significantly lower than the graduate students and the senior majors. Scores decreased with the increase in the ages of the group.

[4] The normative group used in this study is the group which Edwards used in establishing the norms for the 15 variables and the consistency score which are presented in the manual.

TABLE 1

Means and Standard Deviations for the Teachers, Graduate Students, Senior Majors, Total Physical Education Group, and Normative Group for the 15 Variables and the Consistency Score Measured by the Edwards Personal Preference Schedule

Variable	Teachers		Graduate Students		Senior Majors		Physical Education		Norm	
	M	S.D.	M	S.D.	M	S.D.	M	S.D.	M	S.D.
Achievement	13.03	4.04	13.16	4.75	12.61	3.91	12.91	4.13	13.08	4.19
Deference	14.64	3.41	13.47	3.91	12.73	3.67	13.65	3.74	12.40	3.72
Order	13.14	4.47	11.00	3.67	10.76	4.24	11.75	4.40	10.24	4.37
Exhibition	13.41	3.71	14.56	3.48	14.89	3.78	14.26	3.82	14.28	3.65
Autonomy	10.98	3.64	12.40	3.43	11.07	4.26	11.32	3.91	12.29	4.34
Affiliation	17.13	3.67	16.96	3.36	17.47	4.36	17.35	3.87	17.40	4.07
Intraception	17.60	4.54	17.76	4.03	17.91	5.18	17.84	4.65	17.32	4.70
Succorance	11.14	3.96	12.02	3.90	10.95	4.51	11.26	4.21	12.53	4.42
Dominance	15.45	4.25	14.07	4.53	14.73	3.57	14.87	4.14	14.18	4.60
Abasement	14.68	4.46	14.71	5.18	14.89	4.59	14.85	4.67	15.11	4.94
Nurturance	15.93	3.82	14.78	3.91	15.80	4.08	15.63	4.01	16.42	4.41
Change	15.58	4.86	17.47	4.08	17.64	4.11	16.79	4.55	17.20	4.87
Endurance	15.48	4.95	14.29	4.05	14.44	5.05	14.82	4.83	12.63	5.19
Heterosexuality	12.12	4.90	12.89	5.07	14.48	6.00	13.30	5.55	14.34	5.39
Aggression	9.83	4.15	10.11	4.82	9.65	3.70	9.84	4.11	10.59	4.61
Consistency	11.64	1.72	11.56	1.56	11.55	1.95	11.59	1.78	11.74	1.79

TABLE 2

Significance of Difference Between Teachers-Graduate Students, Teachers-Senior Majors, Graduate Students-Senior Majors, Teachers-Normative Group, Graduate Students-Normative Group, Senior Majors-Normative Group, and Total Physical Education Group-Normative Group for the 15 Variables and the Consistency Score Measured by the Edwards Personal Preference Schedule

Variable	Teachers-Graduate Students t	Teachers-Senior Majors t	Graduate Students-Senior Majors t	Teachers-Norm t	Graduate Students-Norm t	Senior Majors-Norm t	Physical Education-Norm t
Achievement	.1752	.7439	.7325	.1126	.1260	1.1153	.5788
Deference	1.8442	3.7950[A]	1.1475	6.0754[A]	1.9533[G]	.8399	4.6108[A]
Order	3.1878[B]	3.8443[A]	.3659	6.0809[A]	1.4413	1.1431	4.7501[A]
Exhibition	1.9154[G]	2.7835[B]	.5335	2.1991[D]	.5769	1.5167	.8382
Autonomy	2.3954[C]	.1599	2.0994[E]	3.2881[B]	.2230	2.6713[B]	3.3145[A]
Affiliation	.2830	.5934	1.0526	.6785	.9070	.1513	.1934
Intraception	.2294	.4479	.2032	.5745	.7717	1.1762	1.5225
Succorance	1.3239	.3152	1.5310	3.2378[B]	.9223	3.2862[B]	4.0943[A]
Dominance	1.8365	1.2906	.9219	2.7644[B]	.1678	1.3885	2.2310[D]
Abasement	.0347	.3267	.2149	.8902	.5512	.4444	.7648
Nurturance	1.7490	.2315	1.5150	1.1770	2.9441[B]	1.1435	2.6377[B]
Change	2.5588[C]	3.2197[B]	.2415	3.1159[B]	.4676	.9779	1.2184
Endurance	1.6008	1.4636	.1990	5.3521[A]	2.8474[B]	3.3413[A]	6.1349[A]
Heterosexuality	.9092	3.0303[B]	1.7344	4.1815[A]	2.0199[F]	.1951	2.5993[B]
Aggression	.3589	.3222	.6086	1.6903	.7101	2.3011[D]	2.4358[C]
Consistency	.2795	.3444	.0470	.5414	.7948	.9183	1.1712

[A]Significant at better than the .1% level of confidence.
[C]Significant at the 1% level of confidence.
[E]Significant at the 3% level of confidence.
[G]Significant at the 5% level of confidence.
*Significant at the 1% level of confidence.
[B]Significant at better than the 1% level of confidence.
[D]Significant at the 2% level of confidence.
[F]Significant at the 4% level of confidence.
*The only difference in favor of the whole-direct repetitive method.

A significantly lower mean was evidenced when the total physical education group was compared with the normative group on the *autonomy* variable; for, although graduate students were higher than the norm, the teachers and seniors were significantly lower than the norm and the graduate students.

All of the physical education groups had means which were higher than the norm for the *intraception* measure. Scores decreased with an increase in age. The total group was higher than the norm, but none of the differences on intraception were statistically significant.

The physical education group was significantly lower than the norm in *succorance*. All of the individual groups were also lower than the norm, and seniors and teachers were significantly lower. The three physical education groups did not differ significantly, but graduate students were slightly higher than senior majors and teachers.

In *dominance*, the total group was significantly higher than the norm. Teachers were significantly higher, and senior majors were higher but not significantly so. The graduate students were lower than the norm, and there were no significant differences between physical education groups.

Abasement was lower for the physical education group than for the normative group. There was a decrease in abasement with an increase in the age of the group. None of these differences were significant, however.

In *nurturance* the physical education group was significantly lower than the normative group, and each of the individual groups was lower than the norm. The physical education groups did not differ significantly.

The difference between the total group and the normative group was not significant, although the total group was lower, on the *change* variable. The graduate students and the senior majors had means which were higher than the norm, but the teachers had a significantly lower mean than graduates, seniors, and norm.

The greatest difference between the total group and the normative group was found on the *endurance* variable with the physical education group being significantly higher. Each of the three groups was higher than the norm, and the three groups did not differ significantly when compared. Graduates were lower than teachers and seniors, however.

In *heterosexuality*, the physical education group was significantly lower. Graduate students and teachers were significantly lower than the norm, and seniors were higher than the norm but not significantly so. There was a decrease in the heterosexuality with an increase in age.

The total group showed less *aggression*, and this was a significant difference. All of the groups were lower than the norm in aggression. There were no significant differences between physical education groups.

No differences were significant on the *consistency* score, but consistency did tend to increase with the increasing age of the group.

There were no significant differences on the *achievement* and *affiliation* variables.

Discussion

The results of this study indicate that a general pattern or type of personality exists among persons in physical education. The conjectures which follow are made on the basis of these results.

The significantly higher mean of the physical education group on deference indicates that persons in physical education are extremely open to suggestions, eager to learn from the example set by others, and willing to follow the leadership of others.

The persons in physical education were also significantly higher on dominance, which indicates they are eager to be leaders, to make group decisions, and to direct the actions of others. Since this variable is almost an opposite to deference, it is rare to find the combined emphasis of these two variables —deference and dominance. This combination, however, is a desirable one and is characteristic of persons who make not only strong leaders but also strong followers.

The higher mean on order typifies persons who are organized, systematic, and interested in planning for the details involved in their work. The higher mean on endurance infers the ability to carry out these plans, to work long hours without interruption, to work hard at a task until it is finished, and to stay with a problem until it is solved. These variables, order and endurance, are decidedly desirable characteristics for persons in any profession.

A lower mean on autonomy is expressive of a lack of desire to be independent in decisions, a lack of desire to do things which are unconventional, and a lack of desire to criticize persons in positions of authority; therefore it would follow that persons high in deference would probably be low in autonomy, as was the case in this study.

The lower mean in succorance indicates that persons in physical education are not "leaners," that is, they are not interested in having others do many small favors, having others hear their problems, and having others attempt to help them continually with their difficulties. The lower mean in nurturance was unexpected, since lack of succorance usually accompanies an emphasis on nurturance; however, it is possible that lack of succorance in oneself accompanies a desire to repress its development in others. These physical education people may have rejected nurturance because it tends to foster succorance in the person nurtured.

The erratic results of the graduate students may have been caused by the smaller number in the sample. The fact that the graduate students were not a homogeneous group with respect to background of experiences may also have influenced the results.

The lower mean on heterosexuality showed that these persons in physical education placed less emphasis on romantic associations with members of the opposite sex. More of an opposite to the traditional "clinging vine" type of woman is indicated here. The higher dominance of the physical education group would support this conjecture as a logical one.

Aggression is generally misunderstood to mean the same as dominance. Although both infer leadership, dominance is the happier and more desirable form of leadership. Aggression is characterized by the person's attacking contrary points of view, criticizing others, getting revenge for insults, and blaming others when things go wrong. The lower mean of the physical education group was desirable in light of this interpretation, although it will generally be regarded as an unexpected one because of the general connotation of aggression.

Conclusions[5]

1. The successful women in physical education who participated in this study tended to score significantly higher than the normative group in the following personality variables as measured by the Edwards Personal Preference Schedule: deference, order, dominance, and endurance.

2. The total group of subjects who participated in this study scored significantly lower than the norm on the autonomy, succorance, nurturance, heterosexuality, and aggression variables of the Edwards Personal Preference Schedule.

3. Although there were significant differences among teachers, graduate students, and senior majors, these differences were not as numerous as the differences between the physical education group and the normative group. When groups were combined, the total group was statistically distinguishable from the normative group on nine of the 15 variables measured by the Edwards Personal Preference Schedule.

4. On the basis of the scores made on the Edwards Personal Preference Schedule, it was concluded that there tended to be an existing pattern of similarity of personality variables among the 255 successful women teachers, graduate students, and senior majors in physical education who participated in this study.

Recommendations

1. That a normative study be conducted in a similar manner with similar subjects using the Edwards Personal Preference Schedule.

2. That vocational guidance personnel in institutions of higher learning and in secondary schools be provided with the established norms.

3. That the physical education staff in the institutions of professional preparation and in secondary schools be encouraged to cooperate with the guidance personnel in the use of the Edwards Personal Preference Schedule

[5] Conclusions are based on the significant differences between the total physical education group and the normative group.

as an aid in the selection and guidance of prospective teachers of physical education.

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Influence of Perceptual Stimulus Intensity on Speed of Movement and Force of Muscular Contraction[1]

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Abstract

The net speed of arm movement made in response to sounds of 45, 65 and 85 db. loudness was measured by chronoscope. Reaction time was excluded. Thirty-six college men were tested. In another experiment, the force of successive contractions of the forearm muscles in response to serial auditory stimuli spaced 5 sec. apart was measured by a recording dynamometer. In both experiments there was a balanced order of presenting the three stimulus intensities. In general, the louder sounds produced faster arm movements and stronger contractions of the muscles. In explanation, it is postulated that greater perceived stimulus intensity results in stronger excitation of the pyramidal tracts and consequently more forceful muscular contractions.

TOTAL motor response time is composed of two aspects: reaction time and movement. The reaction phase is the latent time between the presentation of the stimulus and the first beginning of muscular movement. Movement time is the elapsed time from the beginning of muscular movement to its termination.[2]

In the past, psychological experiments in this field have been concerned with reaction time. In physical education activities, movement time is fully as important. Henry (5) and his students (1, 6, 7) have studied reaction time and movement time and found these to be almost completely independent and uncorrelated. This work has been confirmed by Slater-Hammel (8).

Reaction time varies with the intensity of the stimulus. This topic has been reviewed by Woodworth (10). No studies have been found that show whether or not *movement time* is influenced by the intensity of the sensory stimulus that initiates the response. The nearest thing is an old observation by Féré (2), who found there was a greater dynamometer squeeze when voluntary muscle contraction was accompanied by an external sensory stimulus.

Background of the Problem

It is the purpose of this study to test the hypothesis that increasing the intensity of the external sensory stimulus that initiates the motor response will cause a faster speed of movement and greater force of muscular contraction.

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[1]From the Research Laboratories of the Department of Phyical Education. The writer is indebted to Dr. Franklin Henry for advice and encouragement during the progress of the study.

[2]Or, it may be defined as the time from the beginning to some arbitrary standardized part of a movement that may continue further.

For convenience, and to avoid confusion with the neural impulse that actually flows to the muscle, the term *perceptual stimulus* will be used to designate the external sensory stimulus. It is realized that there are complicated psychological implications of the term *perception,* and for this reason its special meaning in the present problem is defined.

The "perceptual stimulus" functions as the instruction or order, received by the subject and to which he responds by carrying out a movement. To accomplish this, he must produce an efferent neural stimulus to the muscle. The external stimulus thus produces a perception, which in turn produces the muscle innervation. The original stimulus does not itself directly excite the muscle.

It is the external stimulus that will actually be varied in intensity in the experiment. No attempt will be made to measure directly the perceived intensity, but it may be assumed that it will also vary, as will be explained later in describing the apparatus. On the basis of available knowledge, it cannot be predicted that there is necessarily any quantitative relation between the intensity of the external or perceptual stimulus and the speed or strength of the muscular response.

Experimental Design

There were two experiments. Each used 36 subjects of whom seven participated in both. They were volunteers secured from University Physical Education classes. All were males.

The general plan for each experiment involved dividing the 36 subjects into three subgroups, A, B and C. The A subjects were started out with the soft stimulus, followed by the medium and then loud. The B subjects started with the medium stimulus, followed by the loud and then the soft. The C subjects used the sequence loud, soft, medium. Since the difference in order of stimuli might cause one subgroup to respond differently than another, particularly in Experiment 2, it was planned to make the statistical interpretation by means of a variance analysis, thus separating out the influence of stimulus order. Practice effects were automatically balanced out in this design.

The subjects were asked not to take part in any strenuous exercise for two hours before reporting for the experiment. Experiment 1 required about 20 minutes, and Experiment 2 about 15 minutes.

Speed of Movement

Apparatus. To measure speed of movement, the arm was swept horizontally from a reaction key to hit vigorously a ball suspended 24 inches to the left of the key (see Figure I).

The subject sat erect, with his left shoulder pointed toward the ball, which was an arm's length away. He faced the warning light, which was midway between the ball and the reaction key. His right hand rested on the reaction key (A). The warning light flashed on, and in one to three seconds (the actual time varying randomly), the sound stimulus ordered him to hit the ball

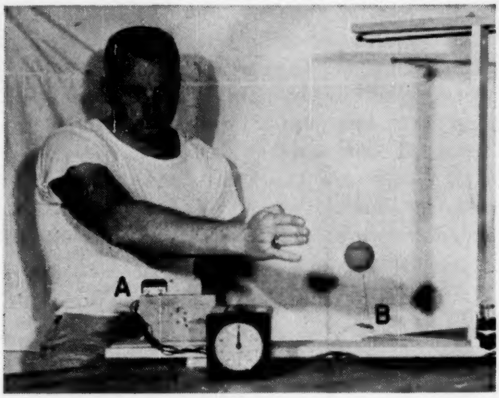

FIGURE I. Speed of Movement Apparatus.

As the hand left the reaction key, the release of downward pressure allowed the contacts to closé, thus starting the chronoscope. Touching the ball caused a contact (B) to pull out of the suspension, thus stopping the chronograph. Only the net movement time was measured. (It would have been interesting to have the reaction time measured also, but the additional chronoscope necessary for this purpose was not available.) The movement was quite forceful, involving the major shoulder and arm muscles. A heavy towel hung behind the ball was found necessary to absorb the recoil of the strike. The chronoscope was a Standard Electric Timer, read to an acuracy of 0.01 second.

The sound was created by an electronic sound generator, previously calibrated and available in the laboratory (6). It produced a 3,000 cycle tone, conducted to the subject by radio operator's head phones. Three intensities were used: a "soft" sound at a sensation level of 45 decibels, a "medium" sound of 65 db. and a "loud" sound of 85 db. The sound heard by the subject was initiated by the experimenter's pressing of a relay switch. Its duration was controlled automatically by this switch so as to last only 0.20 sec. This control of the duration was necessary in order to insure that the perceptual intensities were actually as desired (4). It can be emphasized that the intensity variations used, 20 db., are approximately 40-fold larger than the average intensity variation limens for the sounds used (9, *p. 138*).

Test Procedure. To standardize the procedure, instructions were read to the subject. He was told to watch the ready light, which was flashed on as soon as he depressed the reaction key. After the ready light came, there would be a delay of from anywhere from one to three seconds and then he would receive a sound in the ear phones. As soon as he heard the sound, he was to hit the tennis ball vigorously, and as rapidly as possible. No mention was made to him that the intensity of the sound would be varied.

The experimenter and the apparatus were behind the subject so that he could not see the operation of the control switches or the reading on the chronoscope. He was not informed as to his results until after the experiment, and at that time he was given only general information as to his speed without divulging the true purpose of the tests. The fore-period times were in chance order, arranged beforehand.

Results: Speed of Movement. The loud sound produced a faster speed of movement than the medium intensity (Table 1). There was no real difference between the loudest and the softest intensities, but the softest sound produced a faster reaction than the medium intensity.

TABLE 1
Means and Standard Deviations of Speed of Movement Initiated by Loud, Medium, and Soft Auditory Stimuli

Statistic	Loud (L)	Medium (M)	Soft (S)
Mean (sec.)	0.13366	0.13361	0.13471
Standard deviation	0.02642	0.02610	0.02589

A variance analysis of the data shows that the changes in sound intensities have produced a significant variation in speed of movement (Table 2). The statistical significance of the differences in response to the three intensities is analyzed in Table 3. The most reliable difference is that between the loud and the medium sounds, but the difference between the soft and medium sounds is also significant. There are no other significant findings.

TABLE 2
Variance Analysis of Speed of Movement

Source of Variance	MS	df	F
Total	6,202.03	107	——
Individuals	18,702.11	35	177.34
Intensity	830.50	2	7.87*
Error	105.46	70	——

*F required for significance at 5% level is 3.13.

Muscular Force

Apparatus. A spring-loaded hand ergograph was available in the laboratory. This instrument consisted of a Smedley hand dynamometer, mechanically connected by means of a flexible cable to a writing lever with a well pen mounted on a constant-speed moving paper recorder. A typical 40 kg. maximum squeeze on this instrument resulted in approximately 5 cm. deflection on the recording tape. A detailed description of this apparatus has been given elsewhere (3). The sound stimulus was the same as that used in Experiment 1.

Method. Each of the 36 subjects made 43 contractions for each intensity of sensory stimulus. These stimuli were given in the same order as in the speed of movement tests, but this time the interval between stimuli was always the

TABLE 3

Variance Analysis of Differences Between Speeds of Movement for Sound Stimuli of Loud (L), Medium (M), and Soft (S) Intensities[1]

Source of Variance	L-M			L-S			M-S		
	MS	df	F	MS	df	F	MS	df	F
Total	165.023	35	—	373.180	35	—	211.205	35	—
Stimulus order	21.716	2	0.125	63.695	2	0.163	31.646	2	0.142
Within groups	173.708	33	—	391.937	33	—	222.088	33	—
Difference from zero	2,826.694	1	16.273*	354.694	1	0.905	1,173.063	1	5.282*
Mean Difference	0.002953			0.001018			0.001903		
Reliability (r)	0.988			0.970			0.984		

[1]The mean differences and reliability coefficients are also given as a matter of interest.
*F required for significance at 5% level is 4.14 for difference from zero; 3.29 for stimulus order.

same. The rate was 13 per minute. Preliminary experiments had indicated that by using this rather slow repetition rate, there was no discernible tendency for the subjects to develop a rhythm.

Each record was scored by summing up, for each stimulus intensity, the total deflections on the paper in mm. for the 43 contractions.

Test Procedure. Instructions were read to the subject. He was told to give a maximal contraction every time he heard a sound in the earphones, and then relax completely and wait for the next sound. The contraction was to be made smoothly but with maximal force.

The subject used his preferred hand. He was placed in a position that prevented him from seeing his record. He was permitted to see it after the end of the test, but nothing was said about the variations in sound intensity or the real purpose of the experiment. Judging from the comments made, the subject assumed he was being tested for a fatigue study.

Results: Muscular Force. The medium intensity produced the most forceful contraction (Table 4). It was found that the loud sound produced a greater

TABLE 4

Means and Standard Deviations of Force of Muscular Contraction Initiated by Loud, Medium, and Soft Auditory Stimuli

Statistic	Loud	Medium	Soft
Mean (mm. deflection)	1,680.15	1,680.63	1,667.07
Standard deviation	308.9	315.0	321.4

muscular force than the soft sound. There was no real difference between the medium and the soft intensities.

The statistical significance of the differences is analyzed in Table 5. The most reliable difference is between the loud and medium sounds, although the difference between the loudest and softest sound is also significant.

In this experiment, in contrast to the speed of movement study, there is a significant influence of stimulus order. This probably occurs because the measured response is influenced by fatigue, so that successive responses are considerably different in size. The variance analysis, however, has taken this source of variation into account.

Discussion

This study proceeded on the hypothesis that a more intense "perceptual" stimulus would produce a faster movement time and a greater fore of muscular contraction. It was recognized that the response is not directly to the stimulus, but rather to the neural action that is triggered off by the stimulus. It was postulated, however, that a stronger sensory inflow might somehow tend to cause greater excitation of the pyramidal tracts and thus produce a more vigorous muscular response, even though the detailed mechanism could not be stated. Some justification for this expectation was found in the early

TABLE 5

Variance Analysis of Differences Between Forces of Muscular Contractions for Sound Stimuli of Loud, Medium, and Soft Intensities[1]

Source of Variance	L-M			L-S			M-S		
	MS	df	F	MS	df	F	MS	df	F
Total	1986.006	35	—	1613.692	35	—	897.278	35	—
Stimulus order	18669.694	2	19.15*	5343.527	2	3.851*	6242.750	2	10.89*
Within groups	974.874	33	—	1387.642	33	—	573.189	33	—
Difference from zero	6833.778	1	7.01*	7338.778	1	5.289*	42.25	1	0.07
Reliability (r)	0.9925			0.9908			0.9931		

[1]The reliability coefficients are also given as a matter of interest.

*F required for significance at 5% level is 4.14 for difference from zero; 3.29 for stimulus order. Differences for stimulus order are due to the fact that fatigue curves begin at different places in groups A, B, and C.

experiment by Féré (2), although he did not directly vary the stimulus intensity as was done in the present problem.

The data do show that in general there is a tendency for the more intense sensory stimuli to produce a more powerful response. In Experiment 1, the loud sound produced the fastest speed of movement, which must have been the result of a more powerful contraction of the arm and shoulder muscles. (Reaction time was excluded in this measurement.) In Experiment 2, the sounds of loud and medium intensity produced more ergometer work than the soft sound.

In detail, the results of the two experiments show considerable difference, particularly with respect to the soft sound. One may speculate that in the case of Experiment 1, which concerned the speed of movement, the attention of subjects was greater for the weakest stimulus. For all subjects in this experiment, the series of 90 stimuli came in the sequence soft, medium, loud, soft, etc. The subject could be sure that the loud stimulus would always be followed by the soft stimulus although he did not know just how long a time he would have to wait for the stimulus to appear.

This situation was different in Experiment 2, using the ergograph responses. While the same sequence of soft, medium, loud, soft, etc. was used, the time between the stimuli was always the same. Also (in contrast to Experiment 1), there was no demand on the subject to move just as fast as possible when the stimulus occurred. Thus, the conditions of Experiment 1 would require a greater and more prolonged attention to the stimulus, in order that the response could be started with the least possible delay.

This above discussion offers no explanation of why the stimulus of medium intensity should be just as effective as the loud in Experiment 2, and yet be significantly less effective than the loud sound in Experiment 1. However, it must be recognized that the differences in response to the three intensities of stimulus are extremely small, being 1.4 and 2.2 per cent for the two significant differences in speed of movement and only 0.8 per cent for the two significant differences in ergograph work. The fact that these differences were secured by observing the same subjects at almost the same instant, and for a large number of responses under the three stimuli conditions, has caused very high reliability coefficients and is responsible for the high reliability of the changes. These reliability coefficients ranged from 0.97 to 0.99 in Experiment 1, and were 0.99 in the three interrelationships of Experiment 2. (It is assumed that the correlations between the responses using different stimulus intensities are the equivalent of reliability coefficients.)

Summary and Conclusions

The purpose of the study was to determine the influence of "perceptual" stimulus intensity on the speed of large muscle motor movement and, in a separate experiment, the influence on the force of muscular contraction. The stimuli that were used in both experiments were three intensities of a 3,000-

cycle tone, namely soft (45 db.), medium (65 db.), and loud (85 db.). Thirty-six male subjects were tested in each experiment, making 30 responses per subject for each of the three stimuli in the speed of movement tests and 43 in the muscular contraction tests. A balanced order of administering the stimuli was used in each experiment in order to control effects of practice, etc. Net speed of movement (exclusive of reaction time) was measured in a lateral arm swing in the first experiment. In the second, the force of contraction of the forearm muscles was measured by summing up the successive responses on a spring-loaded ergograph.

The results of variance analysis show that the loud sound intensity produced the fastest speed of movement, but the soft produced a faster time than the medium. With respect to muscle strength, the medium sound produced the greatest contraction, although the loud sound resulted in a more forceful contraction than the soft.

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(Submitted 9/6/57)

Group Dynamics as a Methodology for Democratizing Undergraduate Teacher Education in Physical Education[1]

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Abstract

The purpose of this study was to develop a methodology of democratizing the undergraduate education of prospective teachers of physical education through the use of the principles of group dynamics with particular emphasis on curriculum planning and teaching methods. Many of our present practices in physical education are anti-democratic. A genuine understanding and intelligent application of group dynamics to the undergraduate students majoring in physical education is not only consistent with democratic principles but is vitally needed if physical education is to make its greatest contribution to a democratic society.

THE NEED for this study was based on the cultural crisis in which we live. Democracy's strength lies in its concern for all its citizens. Totalitarian methods, wherever they exist in any of our institutions, weaken democracy. Therefore, if our educational institutions are to make a maximum contribution to the strengthening of democracy, they must constantly seek to apply democratic methods which are consistent with basic democratic beliefs.

Physical educators, no less than all others in education, need to give increasing attention to their basic democratic beliefs and to adopting or revising democratic practices based on those beliefs.

The President's Commission on Higher Education (24), in setting the goals for higher education, has called for a fuller realization of democracy in every phase of living: "To preserve our democracy we must improve it . . . It (education for democratic living) should become . . . a primary aim of all classroom teaching and, more important still, of every phase of campus life." The one basic assumption of this study was that the professional preparation of undergraduate students majoring in physical education needs to emphasize the *process* involved in curriculum planning and teaching, whereas emphasis in the past has been largely on *content*. This assumption is predicated on the conviction that all those affected by decisions should have a voice in making those decisions.

[1] This report is taken from a study, under the direction of Dr. Leonard A. Larson, presented in partial fulfillment of the requirements for the Doctor of Education degree at New York University, 1956.

Statement of Problem

The purpose of this study was to develop a methodology of democratizing the undergraduate education of prospective teachers of physical education through the use of the principles of group dynamics, with particular emphasis on curriculum planning and teaching methods. It was necessary to show the correlation between the definitive components of democracy, as they were evolved from the literature, and the principles of group dynamics. Application of these principles to physical education was the third phase of an attempt to develop a methodology by which democratic beliefs could be translated into democratic action.

Review of Related Literature

It was necessary to analyze the literature in each of three categories. The first source of ideas was from theorists whose writings provided a philosophical background from which principles, values, and methods relevant to group dynamics evolved. Second, there were several studies available in other areas of education which were concerned with group dynamics as they related to curriculum planning and to teaching methods. Third, those studies in physical education which were concerned with the application of group dynamics were presented.

The educational philosophy of John Dewey was highly important in any study dealing with democratization of any phase of higher education. "If there is one conclusion to which human experience unmistakably points it is that democratic ends demand democratic methods for their realization." (10).

Regarding the effects of progressive education on the personality of individuals, Murphy (21) said: "(This type of education) throws out the trappings of competitive education — the marks, honors, and external rewards which often tend to stimulate a false effort at 'good records' whether the good records are accompanied by good development or not."

Lewin (18), in 1944 wrote: "We are moving toward a full-fledged experimental science of group dynamics which will include the problems of leadership and leadership training, ideology and culture, group morale and group production, discipline and group organization, in short, all phases of group life." Numerous studies were also concerned with the needed change from authoritarian to democratic methods (4,5,6,11,18,24,28).

Studies in other areas of education concerned with group dynamics related to curriculum planning and to teaching methods are relatively numerous. Kelley and Rasey (14) said: "The currriculum itself is modified when method is modified. Indeed, revising method is the easiest and most sensible road to curriculum revision. When teachers change from authoritarian to democratic methods, what is learned will change also." Other educational theorists made the same contention (2,7,8,9,12,13,20,25,26,29).

Some physical educators have been concerned with democratic practices in physical education and this concern seemed to have increased considerably in recent years. Baxter and Cassidy (3), in 1943, were concerned with experiences in group leadership in summer camps. Nash, Moench, and Saurborn (22) said that "the distinction between line and staff (in physical education) is disappearing under democratic administration where everyone is taken into the planning." And they contended that acceptable leadership must be thought of in terms of group dynamics. Some other physical educators have made the same assertion (1,15,16,17,23,27).

Procedure

The general approach used in collecting and developing the data in the study was the philosophical method of research. Because of the voluminous amount of material available, particularly concerning democratic thought, it was necessary to be highly selective. There were three criteria on which such a selection was based. One was that the best authorities as recognized by political theorists of standing were chosen. The second criterion, in the chapters on the definitive components of democracy, was that the authors should be contemporary 20th Century authors. Third, the member of the sponsoring committee closest to the field of political and social philosophy—an educational philosopher, approved the selection.

A survey was made of the literature pertaining to the history and evolution of democratic thought and an analysis of the literature was undertaken in order that the definitive components of democracy could be evolved. From this analysis, it became apparent that there were basic and common democratic concepts cited by nearly all the authorities from which were evolved six components of democracy. Other democratic concepts evolved from the literature and were listed and discussed with supportive evidence under one or more of the six basic components of democracy.

A survey was made of the literature pertaining to group dynamics. The main source of this literature was the writing and experiments conducted by, or under the direction of, Kurt Lewin at the Iowa Child Welfare Research Station. Data were also collected from the writings and experiments of other recognized social psychologists and from authorities in other allied fields such as psychology, anthropology, educational psychology, and educational philosophy — fields concerned with the scientific study of man in society.

These data were analyzed with the purpose of evolving principles of group dynamics. Each principle was documented from the literature. These principles were then correlated with the definitive components of democracy by supportive evidence from the literature and by narrative description.

Validity of these three phases of the investigation was established by supportive evidence which was a result of a survey and critical analysis of the literature and by logical reasoning. In other words, validity resulted from

the quality of the documentary support — from the quality of the sources cited—and by narrative description through logical reasoning.

Next, it was necessary to determine the situations in physical education to which the principles of group dynamics could be applied. A survey was made of the literature by leading physical educators pertaining to current practices in the organization and administration of physical education. An analysis of the literature was undertaken with a view to determining the extent to which group dynamics had been applied in specific situations in physical education and to determining other situations, particularly in the areas of curriculum planning and teaching methods, to which group dynamics could be applied.

These applications had to be feasible and realistic and the basis for such applications was determined by supportive evidence from authorities in physical education and other areas of education and by logical reasoning based on documentation. The basic consideration in determining situations to which group dynamics could be applied was the importance of, and the possibilities for, student participation in both curriculum planning and classroom procedures.

The framework for determining these situations was the actual process of curriculum planning and classroom procedure. Stated differently, all planning and decisions now carried on by administrators and faculty members were considered, at least potentially, as situations to which group dynamics might be applied, and in which students might participate.

The validity of the applications was established by the quality of the documentary support cited and by logical reasoning.

Summary of Findings

Six definitive components of democracy were discussed: respect for the dignity and integrity of the individual; faith in the potentialities of man; government by consent of the governed; respect for minority rights; belief in co-operative action; and faith in reason and intelligence.

Five principles of group dynamics, for a *democratic* group, were discussed: a group must have goals which have been reached through participation by all its members; a group must have feelings of emotional belongingness; group goals must be felt to be important and must be integrated with individual goals; there must be confidence in attainment and in the means of attainment of these goals; and group action must be co-operative and integrated.

The role of the democratic leader who attempts to use the principles of group dynamics is extremely important. Generally speaking, he attempts to avoid two extremes: autocracy, where there is little or no participation or group planning, and laissez-faire leadership, where there is no direction and no order to the process. One of the first requirements for such leadership is sufficient security and emotional stability so that the leader has no

emotional need to dominate or manipulate others. Another requirement for the democratic leader is a belief that this form of leadership is more desirable than either of the other types mentioned above. Along with this belief, there must be the necessary knowledge of democratic procedures to convert the belief into action.

A correlation of the definitive components of democracy with the principles of group dynamics appeared to be essentially a correlation of beliefs and methods. Research conducted in this study indicated a definite connection between each component of democracy and each principle of group dynamics.

In discussing the situations in physical education to which the principles of group dynamics could be applied, it was recognized that, traditionally, curriculum planning in colleges and universities has been the sole responsibility of administrators and faculty groups, but in recent years several professional educators have been contending that such planning should also include students (11,13,26,28).

It was contended that students can and should be included in curriculum planning in these four ways: first, in determining the objectives of the departments; second, in determining the courses which are to be required of students majoring in physical education; third, in determining general principles concerning teaching methods; fourth, in determining methods of evaluation regarding both students and faculty members.

Regarding teaching methods, the position was taken that there are at least four distinct situations in professional physical education classes where the principles of group dynamics can be applied (4,5,6,17). First, students can participate in determining the content of a given course with the help and guidance of the instructor; second, students can participate in determining the sources of material to be used and what outside experts, if any, will be called in to aid the group; third, students can participate in determining ways of presenting materials; and fourth, they can participate in determining the methods of evaluation and in the evaluative process itself.

A fundamental assumption of our democratic society is and has always been that ends and means should be consonant; democratic ends do not justify autocratic means. It follows from this that autocratic methods in higher education are not justified if one goal is to produce democratic students. Moreover, considerable evidence indicates that autocratic methods are not only inconsistent with democratic principles but that they are relatively ineffective in producing students who believe in, and have become skillful in, using the methods of democracy.

It seems that an increasing number of educators are realizing that democracy is not something to be "taught" in a few specific courses; it is a way of life and it must be *lived* to be learned. The physical education student's willing acceptance of responsibility and the necessary action to carry out

that responsibility seem much more likely to result when he has actively participated in making decisions which affect him than when the chances for such participation have been lacking.

What one is to learn, how and when he is to learn it and now well he has learned it—these are areas of concern to all undergraduate students of physical education. Students, faculty, and administration need to work co-operatively in the entire process. Leadership must be devoted to providing constant opportunities for other group members to assume leadership, as their experience, interest, and ability equip them to do so. The purpose is to guide, stimulate, clarify, and create; it is not to demand, dominate, or manipulate. Such co-operative action neither expects nor desires conformity or submission.

Those who provide learning experiences for undergraduate students of physical education need to be concerned with the emotional as well as the intellectual needs of human beings in a democratic society. A deep understanding of the principles of group dynamics and a wise application of those principles can make a vital contribution to fulfilling those needs. This, in turn, helps to strengthen democracy.

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Comparative Study of Methodologies for Teaching Gymnastics and Tumbling Stunts

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Abstract

The purpose of this study was to determine whether the whole method or the whole-direct repetitive method was more effective for teaching basic tumbling and gymnastic stunts. Two equated groups of male college students were taught stunts according to one of the two methods for a period of one semester. With the exception of the back roll-snap down in favor of the whole method, there was no statistically significant difference between the two methods.

METHODOLOGY is one of the many research areas in physical education which has been grossly neglected. The modicum of experimentation in methods of teaching motor skills in physical education indicates that, in the long run, the whole method is superior to part methods. Shay (10) found this to be true in teaching the upstart in the horizontal bar as did Combs (1) in teaching track activities and Knapp and Dixon (4, 5) in experimenting with learning to juggle. In another type of methods study in which formal and informal types of methods were employed, Jennings (3) and Kulcinski (6) found that the informal method is slightly more effective than the more formal type. However, very little can be gleaned from the latter type of study because of the number of uncontrolled factors which influence learning.

Purpose

The purpose of this study was to determine whether the whole method or the whole-direct repetitive method was more effective in teaching basic gymnastics and tumbling stunts to male college students.

Procedure

Subjects. Twenty-seven members of the required physical education classes at the State University of Iowa were used as subjects. All stated that they had not had previous experience in learning gymnastics and tumbling skills. The subjects were divided into equated groups which met at different class periods and were taught by the same instructor, according to one of the two methods.

The two groups were equated on the basis of chinning strength, Iowa Revision of the Brace Test, McCloy's General Motor Capacity Test (expressed

as Motor Quotient), and hip flexor strength (measured in terms of number of "half-levers" each could do while hanging from the horizontal bar.) See Table 1.

TABLE 1
Results of Equating the Two Experimental Groups

Test	Whole Method		Whole-Direct Repetitive Method		
	Avg.	S.D.	Avg.	S.D.	t
Chinning Strength (Quotient)	101.03	2.58	100.41	2.87	.551
Iowa Revision of the Brace Test (T-Scores)	50.33	5.20	50.90	8.70	.458
Motor Quotient McCloy's General Motor Capacity)	105.73	4.46	104.91	3.99	.478
"Half-levers" (Number)	20.50	4.15	21.70	3.63	.759

Selection of Stunts. Fifteen tumbling, 16 parallel bar and 17 horizontal bar stunts were selected from various sources as representative stunts, progressing in difficulty from the elementary to the advanced intermediate level. The form for each of these stunts was described in detail and analyzed, using the mechanical principles developed by McCloy (7). In this manner, it was ascertained that the stunts were taught according to form which was mechanically correct.

From the total number of stunts, four on the horizontal bar, three on the parallel bars and three on the tumbling mat were selected as stunts which were of sufficient difficulty to provide quantitative differences in learning among the subjects and yet were within the scope of learning capacity for each subject, within the time range of the experiment.

Teaching Periods. Each group had a full hour of participation twice each week for a period of 14 weeks.

Presentation of Stunts. In order to familiarize the subjects with the apparatus, simple introductory skills were presented during a period before the experimentation began. The sequences for presentation of stunts for each piece of apparatus and for tumbling were as follows:[1]

Horizontal Bar

1. From front hang, back circle under bar to back hang.
2. From front hang, back circle to front rest.
3. Hockswing dismount.*
4. Backward double hand-knee circles.*
5. Ordinary upstart.*
6. Forward front heel upstart from under bar to a side seat.*

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[1] Asterisk indicates stunts selected for teaching using the experimental methods. All stunts not indicated by an asterisk were taught to both groups by the whole method.

Parallel Bars
1. Jump mount.
2. Rear vault dismount
3. Front vault dismount.
4. Shoulder balance.*
5. Upper arm hand upstart.*
6. Back upstart.*

Tumbling
1. Forward roll.
2. Long dive.
3. Squat balance.
4. Back roll snap-down.*
5. Forward handspring.*
6. Snap-up.*

Whole Method. The stunt was demonstrated and described in detail. It was demonstrated and described a second time, and any questions relative to the instructions were answered. The subjects then began to practice the stunt as a whole. If there were errors in performance, the necessary corrections in form were made until the reason for failure was eliminated. The stunt was always practiced as a whole until it was learned.[2] Instruction for stunts which had been practiced in the previous class period but had not been learned were reviewed at the beginning of the next period.

Whole-Direct Repetitive Method. The stunt was demonstrated and then described in detail. It was then demonstrated and described a second time, and any questions relative to the instructions were answered. When there were no further questions, it was assumed that the subjects all understood the nature of the whole stunt.

The first part of the stunt was then demonstrated, described, and demonstrated again. Each subject practiced the first part until he could execute it with the form required in performing the whole stunt. The combined first and second parts were then described, demonstrated, and practiced until learned. This procedure was continued until all the parts were added, and the stunt was then practiced as a whole. In two instances, where the last logical part of a stunt was rather difficult, and could be isolated (back roll-snap down and ordinary upstart), that part was practiced separately before being added to the part or parts previously practiced. This is the progressive-part method and it should be noted that a whole-modified direct-repetitive method was used in teaching these two stunts.

Class Details. Not more than five trials were permitted for a given stunt on any one day, unless a subject had successfully executed the stunt and attempted to repeat it the number of times necessary to satisfy the criterion for learning.

In order to keep the amount of participation in the class constant, each group continued to practice the stunt each day until the entire group had

[2]In this study the criterion for learning was three consecutive, successful performances in the stunt.

learned it. A new stunt on a piece of apparatus was presented after one-half the class had learned the preceding one. The order of practice on the three pieces of apparatus was alternated each period.

Method of Recording Performances. The purpose of this study was to determine which of two methods was the more effective in teaching gymnastics and tumbling stunts. Effectiveness, as used in this study, refers to the amount of time required for learning the stunts. Speed of learning for both methods was measured in terms of the total number of trials required to satisfy the criterion for learning. For the group learning the stunts according to the whole method, the performance was merely recorded as being a success or a failure. The part or parts being practiced according to the whole-direct repetitive method were scored as being successful or failing in relation to the criterion for that particular phase of the stunt.

Analysis of Data

The data collected on the two experimental groups contained, in the distribution of scores for each stunt, extreme cases which caused the distribution to depart markedly from the normal. This situation made it impossible to utilize statistical techniques based upon the normal probability curve. Thus, a relatively new statistical device was employed. A non-parametric test for the significance of the difference between the two groups was used rather than the traditional t-test. Of the several non-parametric tests recently developed, the Median test (9) appeared to be the most suitable test for the data which were collected.[3]

Table 2 contains data relative to the comparison of the two methods according to stunt and according to the total scores for ten stunts for each subject. The comparisons by stunt indicated that the only item in which the difference between the two methods was statistically significant (2.35 per cent level of confidence) was the back roll-snap down and this was in favor of the whole method. None of the other comparisons showed a difference significant within the criterion of the 5 per cent level of confidence.

When a comparison of the two methods was made on the basis of the total scores of all ten stunts for each student, the 19.76 per cent level of confidence was below the acceptable level and it must, therefore, be concluded that there was no significant difference. Thus it appears that with the exception of the back roll-snap down, there is no demonstrable difference in the effectiveness of the two methods when judged by statistical significance.

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[3] It should be noted that the median test and the t-test may be used interchangeably on a small sample (8). A comparative study, by the writer, of the Median Test and the t-test using hypothetical data, for two groups of 20 subjects, revealed little difference in the significance of the final result. Using the t-test, the difference was significant at the 10.45 per cent level of confidence; using the median test, the difference was significant at the 11.51 per cent level of confidence.

TABLE 2

Levels of Significance for the Difference Between the Two Experimental Groups

Stunt	Level of Confidence %
1. Back roll-snap down	2.35
2. Handspring	25.41*
3. Snap-up	7.41
4. Hockswing dismount	19.76
5. Ordinary upstart	19.76
6. Back double hand-knee circles	29.64
7. Front heel upstart to side seat	29.64
8. Shoulder balance	11.86
9. Upperarm upstart	7.41
10. Back uprise	7.41
Total scores (Comparison on the basis of each subject's total score for all ten stunts)	19.76

*In the handspring, the whole-direct repetitive method was slightly more effective. In all the other cases, the whole method was more effective.

A more thorough understanding of the nature of the data is provided by the information as presented in Tables 3 and 4. This includes a comparison of the rate of learning of the two groups by calculating the mean number of trials for each stunt and the median number of trials for each stunt. A comparison of the medians showed that there was no difference in the number of trials required to learn two of the stunts (shoulder balance and front heel upstart to side seat); fewer trials were needed to learn the forward handspring using the whole-direct repetitive method; and fewer trials were needed to learn the other seven stunts (back roll-snap down, snap-up, hockswing dismount, ordinary upstart, back double hand-knee circles, upper arm upstart, and back uprise) using the whole method.

TABLE 3

Comparison of the Medians for Each Stunt

Stunt	Whole Method	Whole-Direct Repetitive Method	Difference
Back roll-snap down	10	24.5	14.5
Handspring	29	21.0	8.0*
Snap-up	12	34.0	22.0
Hockswing dismount	7	11.5	4.5
Ordinary upstart	47	86.5	39.5
Back double hand-knee circles	51	56.0	5.0
Front heel upstart to side seat	20	20.0	0.0
Shoulder balance	4	4.0	0.0
Upperarm upstart	13	22.0	9.0
Back uprise	22	39.5	17.5

*The only difference in favor of the whole-direct repetitive method.

TABLE 4
Comparison of the Means for Each Stunt

Stunt	Whole Method	Whole-Direct Repetitive Method	Difference
Back roll-snap down	12.9	39.6	26.7
Handspring	57.6	65.6	8.0
Snap-up	27.7	42.3	14.6
Hockswing dismount	11.7	12.5	.8
Ordinary upstart	58.0	96.5	38.5
Back double hand-knee circles	53.0	67.5	14.5
Front heel upstart to side seat	20.1	29.4	9.3
Shoulder balance	4.5	6.1	1.6
Upperarm upstart	15.6	27.3	11.7
Back uprise	30.7	38.4	7.7

The above comparison of the two methods using the medians for each stunt revealed that in seven out of the ten items fewer trials were needed to satisfy the criterion of learning when the whole method was used. A similar comparison using the means for each stunt indicated that fewer trials were required to learn in all ten of the cases when the whole method was used.

Conclusions

1. The whole method was more effective in teaching the back roll-snap down. There was no other significant difference between the two methods when comparing single stunts.

2. There was no statistically significant difference between the two methods when comparing on the basis of the total scores of all ten stunts for each subject.

3. The conclusions of the other studies relative to the greater effectiveness of the whole method should not be rejected because of the above conclusions. A preponderance of evidence in this study showed that while the difference between the two methods was not statistically significant, learning according to the whole method, generally, required fewer trials. Further research in this area is indicated.

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(Submitted 7/16/57)

Notes & Comments

NOTES

Proposed Scoring System for Buxton Revision of Kraus-Weber Test

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THE KRAUS-WEBER Test was designed originally to single out people who would in all probability develop low back pain. In order to use this test for diagnosing the muscular fitness of children in physical education classes, certain adjustments are necessary in the scoring if there are to be differentiating scores at all levels of ability.

The purpose of this study was to determine the 75th, 50th, and 25th percentiles which could be used as standards for diagnostic purposes for this author's revision of the Kraus-Weber Test as presented in the *Research Quarterly*, October 1957 (1). The original data were obtained from 1,057 Iowa school children between the ages of six and 15 years on a test battery in which the Kraus-Weber Test was altered through the addition of tests for the arms and legs and modifications in the scoring of the original items. The test descriptions, results of the testing, and the numbers of children involved will not be repeated here, as this information is available in detail in the previous article. Since the data were collected from children in Iowa, it is realized that their scores would not be identical to those of children from other areas. The Iowa children, however, scored lower on the original Kraus-Weber Test than children from other localities (2, 3, 4) so that their extended scores should not represent an excessive level of achievement.

Tables 1 and 2 present the quartile points which coincide with the 75th, 50th, and 25th percentiles for girls and boys respectively. These suggested levels of attainment

TABLE 1
Norms for Girls

Test	Quartile	Age 6	7	8	9	10	11	12	13	14	15
Repeated	Q_3	13	17	22	17	21	19	22	25	25	26
Sit-Ups	Mdn	5	7	7	7	13	12	16	18	17	20
(*Number*)	Q_1	1	1	1	1	9	7	7	13	10	10
Push-Ups	Q_3	11	8	10	15	15	13	14	17	10	14
(*Number*)	Mdn	4	4	5	8	6	4	5	6	5	6
	Q_1	1	1	1	2	2	2	3	2	1	3
Upper Back	Q_3	180	178	180	180	180	180	180	180	180	180
(*Seconds—*	Mdn	129	123	125	144	149	157	143	180	180	180
180 Maximum)	Q_1	77	80	87	90	99	94	85	146	142	125
Lower Back	Q_3	180	180	180	180	180	180	180	180	180	180
(*Seconds—*	Mdn	180	180	180	180	180	140	167	180	142	180
180 Maximum)	Q_1	106	159	109	109	79	82	73	96	76	101
Psoas & Lower	Q_3	78	74	53	66	57	44	39	41	30	41
Abdominals	Mdn	55	42	29	32	25	22	20	20	18	24
(*Seconds*)	Q_1	30	18	18	19	14	12	8	13	10	14
Leg Strength	Q_3	8	9	10	10	11	12	12	13	13	14
(*Inches*)	Mdn	7	8	8	9	10	11	11	12	12	13
Flexibility	Q_1	7	7	8	8	9	10	10	10	11	11
(Trial One)	Q_3	1	1¼	1¾	¾	¾	1	¼	2¼	2½	1
(*Inches—*	Mdn	0	¼	0	−½	−½	−½	−1¾	0	−¼	0
Toe level = 0)	Q_1	−1¾	−1½	−3¼	−3	−3	−2¾	−4½	−2¾	−3¾	−3

should give physical educators more of a basis for diagnosing the muscular fitness of children in the age range six through 15 than is now available in the pass or fail scoring of the Kraus-Weber Test.

TABLE 2

Norms for Boys

Test	Quartile	Age 6	7	8	9	10	11	12	13	14	15
Repeated	Q_3	13	20	21	27	23	23	33	33	46	49
Sit-Ups	Mdn	7	8	12	15	18	14	20	20	34	33
(*Number*)	Q_1	0	1	5	7	10	9	9	11	11	21
Push-Ups	Q_3	11	14	25	28	30	31	39	58	62	61
(*Number*)	Mdn	6	10	11	17	22	16	23	33	42	42
	Q_1	1	5	4	9	10	9	11	14	28	31
Upper Back	Q_3	123	177	174	180	180	180	180	180	180	180
(*Seconds—*	Mdn	89	121	100	114	129	152	140	180	159	151
180 Maximum)	Q_1	60	83	65	83	80	108	93	121	121	103
Lower Back	Q_3	180	180	180	180	180	180	180	180	180	180
(*Seconds—*	Mdn	180	180	180	180	180	180	180	127	180	122
180 Maximum)	Q_1	105	135	115	113	121	123	108	80	92	91
Psoas & Lower	Q_3	83	73	59	63	49	55	47	51	59	51
Abdominals	Mdn	49	39	29	45	25	29	29	22	37	32
(*Seconds*)	Q_1	24	22	12	21	13	14	13	13	17	16
Leg Strength	Q_3	9	10	10	11	12	12	13	15	16	17
(*Inches*)	Mdn	8	8	9	10	11	11	11	12	15	16
	Q_1	7	7	8	8	10	10	10	11	13	14
Flexibility	Q_3	¾	1	½	½	¼	−1¼	−2	¾	¼	2
(Trial One)	Mdn	−1	−1	−¾	0	−1½	−3	−3¼	−1¾	−2¼	0
(*Inches— Toe level = 0*)	Q_1	−3	−3	−2¾	−4	−3¼	−4½	−5	−5	−4½	−3½

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The One-Tailed Test in Physical Education Research

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Although the one-tailed test is a relative newcomer to physical education research, it gives promise of becoming an increasingly popular technique for evaluating the differences between treatment means. After all, it does have the advantage of being more sensitive to these differences, and it thus offers the possibility for finding a greater number of significant differences.

It must be recognized, however, that the increase in sensitivity is not completely free and clear; it is achieved only through a restriction of the admissible alternative hypothesis. In the traditional two tailed t-test, the alternative hypothesis provides for the

differences between means being either greater or smaller than zero. The one-tailed test, on the other hand, provides for only one of these alternative conditions. In short, the one-tailed test is concerned solely with the reliability of a difference in a specified direction. While this distinction between the two test models should not be difficult to comprehend, there does appear to be considerable confusion as to precisely what is involved in the directional nature of the one-tailed test.

Representative Case

An interesting and representative case in point is to be found in a recent report by Clarke (3). In this report on the "strength-decrement fatigue effects" of submaximal exercise on a treadmill, the data consisted of pre- and post-exercise strength measurements for 14 muscle groups from 14 groups of 17 subjects each. Since the evaluation was confined to individual comparisons of each muscle group, the general procedures may be considered to involve a series of experiments with repeated measurements.

In describing the test model for his individual comparisons, the investigator states:

> For 17 subjects, t values of 1.75 and 2.58 denote significance at the .05 and .01 levels of confidence respectively. These values for t were chosen because significance was measured from zero, of no difference, in a positive direction only. In explanation, when the hypothesis tested postulates difference in one direction only, the probability yielded by t as given in ordinary tables may be halved.

While the concern over differences "in a positive direction only" seems rather unusual, one might expect "strength-decrement fatigue effects" to involve a negative direction—and while there appears to be some failure in discriminating between the null hypothesis under test and the alternative hypothesis, it is clear that the probability of t for each of the 14 comparisons was based upon one tail of the t-distribution. In short, a one-tailed test was used to assess the differences between pre- and post-exercise strength measures.

In the assessment of his differences, however, the investigator included two distinct classes of results: (1) those muscles groups in which post-exercise means were smaller than pre-exercise means, and (2) those muscle groups in which post-exercise means were larger than pre-exercise means. Of the nine differences which fell into the first class of results, only two were found to be significant: and these were interpreted as "strength-decrement fatigue effects." Although none of the five differences falling into the second class of results reached an acceptable level of significance, it was concluded that: "Quite possibly a warm-up effect of muscles not involved in the run may account for this result." For a one-tailed evaluation of data, these would seem to be strange outcomes.

Now it is within the realm of possibility that the investigator was able to call his shots with unerring accuracy, that he was able to distinguish among his muscle groups those which would show a "strength-decrement fatigue effect" and those which would show a "warm-up effect." But this seems highly unlikely. For one thing, the investigator is quite specific in stating that the purpose of his study "was to examine the strength-decrement fatigue effects of 14 muscle groups of the trunk and lower extremities resulting from a sub-maximal treadmill run. . . ." For another thing, there is the statement that "significance was measured from zero, or no difference, in a positive direction only."

About the only conclusion to be reached is that the one-tailed test "in a positive direction only" was interpreted as involving no more than a simple subtraction rule whereby the larger treatment mean always became the minuend and the smaller the subtrahend. This rule, which is precisely that used in the two-tailed test, will always give a difference in a positive direction; and it seems to have been accepted as sufficient for a one-tailed evaluation of strength measures. Presumably, it was deemed satisfactory to perform the following sequential steps: (1) assess the significance of the positive differences between means with the positive tail of the t-distribution, (2) note the actual sign of the differences, and (3) classify results as "strength-decrement fatigue

effects" and "warm-up effects." These steps, however, simply provide for a situation in which the specification of directional hypothese and statistical tests arise from the experimental data, and it is suggested that they are consonant with neither the rules of experimental verification nor the one-tailed test model.

As indicated earlier, the one-tailed test is concerned exclusively with the reliability of a difference in a specified direction. In assessing the difference between treatment means with a one-tailed test, the investigator declares himself to be interested in one, and only one, of the following predictive hypotheses: (1) the difference between treatment means is greater than zero; or (2) the difference between treatment means is less than zero. The particular directional hypothesis, of course, must be specified *prior* to examination of the experimental data. To attempt to verify hypotheses with the data from which they arise is to misinterpret both the nature of hypotheses and the rules of experimental verification. As succinctly stated by Kempthorne: "Hypotheses that are formulated from or modified by the observations are always suspect, and it is one of the elementary notions of statistical test that probability statements cannot be made about statistical tests suggested by the data to which they are applied" (7, p. *4*).

Illustration of One-Tailed Test

As a means of illustrating an adequately specified one-tailed test of a difference between treatment mean, let it be assumed that theoretical considerations, or even a practical consideration, led Clarke to be interested solely in the possibility that treadmill running would decrease strength measures. In this case, the investigator's directional hypothesis (H_d) may be symbolically designated as, H_d: $m_e - m_c < 0$, where m_e is the population mean under the experimental condition of post-treadmill running, and m_c is the population mean under the control condition of pre-treadmill running. The hypothesis to be tested (H_o) will take the form, H_o: $m_e - m_c \geqq 0$. And rejection of this hypothesis at some designated confidence level would lead to acceptance of the directional hypothesis.

It is to be noted that the "null" hypothesis as formulated above provides for the several classes of events which will not permit acceptance of the particular directional hypothesis under consideration. Although it may seem odd that the hypothesis tested should include a class of events opposite to the directional hypothesis, it must be remembered that an investigator's directional interest, or bias, does not preclude the possibility of an experimental difference falling in the opposite direction. Failure to provide for this contingency may place the investigator in the unenviable position of having to defend a propostion of no difference "if results actually show a large difference in the direction opposite to that predicted" (6, *p. 585*).

It is also to be noted that the comments of this note are concerned exclusively with the requirements for an adequately specified one-tailed test model. As far as the extent to which the one tailed-test is applicable to physical education research problems, it is recommended that the interested reader consult the recent series of provocative articles by Burke (1,2), Hick (4), Jones (5,6), and Marks (7).

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3. CLARKE, H. H. Strength decrement of muscles of trunk and lower extremities from submaximal treadmill running, *Research Quarterly*, **28**: 95-99, 1957.
4. HICK, W. E. A note on one-tailed and two-tailed tests, *Psychol. Rev.*, **59**: 316-318, 1952.
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7. KEMPTHORNE, O. *The Design and Analysis of Experiments*. New York: John Wiley & Sons, Inc., 1952.
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(Submitted 9/5/57)

Research Abstracts

Prepared by the Research Abstracts Committee of the National Council of the Research Section, PAUL A. HUNSICKER, Chairman

1. Acheson, Ray M., and C. Wesley Dupertius. The relationship between physique and rate of skeletal maturation in boys. *Human Biology.* **29**: 2: 167-193 (May 1957).

Skeletal maturity was assessed from x-rays of the hip and pelvis by the Oxford method on 225 boys. The linear regression between ectomorphy and rate of maturation differed significantly from zero, and this component being highest among the slow maturers. There was a tendency, not significant, for endomorphy and mesomorphy to be higher among the faster maturers. Boys with over 5 in ectomorphy were significantly taller and slower maturing than boys with over 5 in mesomorphy. A non-statistical analysis of the maturational time-pattern in the articular epiphysis, traction epiphipis, and primary center in extreme ectomorphs and mesomorphs suggests that the time-pattern varied with physique.—*D. B. Van Dalen.*

2. Albanese, A. A., *et al.* Protein and amino acid needs of the aged in health and convalescence. *Geriatrics,* **12**: 465-475 (Aug. 1957).

A five-year study was undertaken on healthy aged women to determine if nutritional status is good with a minimum daily intake of protein. It was shown that 54 ± 5 gm. of protein of which 39% was from meat did maintain good status. A self-selected diet of 1,560 calories was used. During convalescence from any cause, 39 subjects consumed 64-98 gm. of protein daily in diets providing 1,935-3,484 calories. Meat proteins averaged 27% of the total protein diet and the diet was self-selected. About 50% of the convalescent group were in negative nitrogen balance even with the high food consumption. When 600-900 gm. of lysine was added daily 60% of the patients improved the N-balance. The indication is that small additions of lysine to the diet of elderly adults under nutritional stress enhances the biologic value of the diet particularly when low in meat protein—*E. D. Michael.*

3. Barnett, C. D., and G. N. Cantor. Pursuit rotor performance in mental defectives as a function of distribution of practice. *Perceptual and Motor Skills.* **7**: 191 (1957).

Fifty-two male defectives were divided into 4 groups matched on the basis of scores obtained on preliminary trials on a pursuit rotor. One group received distributed practice on day 1, followed by mass practice on day 2. In group 2, the practices were reversed. Group 3 received massed practice on both days. Group 4 had distributed practice on both days. The total amount of time spent in practice was the same. A test trial was given on day 2 following a 5-minute rest, which was preceded by the practice session. Results confirmed those found with normal subjects, e.g., that the distributed practice group was significantly better on the performance test on day 1, and that significantly more reminiscence followed massed than distributed practice. — *C. Etta Walters.*

4. Beal, Virginia Asta. Nutritional intake of children. Vitamins A and D and ascorbic acid. *J. Nutrition.*

As part of the study of growth and development of children by the Child Research Council, nutrition histories are taken at monthly intervals during the first 6 months of life and thereafter at intervals of three months. Nutrients are calculated from food value tables. The data are based on 1,008 histories of 64 children during the first 5 years of life.

Intakes of vitamins A and D and of ascorbic acid are presented as 25th, 50th, and 75th percentiles and total range with reference to age. Intake of animal sources of vitamin A shows a small range at each age and little variation from age to age. Plant sources show more variation, with a marked peak at the end of the first year, a decline in the early pre-school years followed by a rise after three years of age; plant sources supply an average of 40-60% of the total dietary vitamin A after the first 4 months. For most of this age span 75% of these children exceed the N.R.C. Recommended Allowance in dietary vitamin A intake; in addition, concentrates are given an average of 64% of the time.

Median vitamin D intake reaches a peak of 1,000 I.U. daily at 4 to 6 months, then decreases to a level just below 400 I.U. by 5 years. During the first 6 to 9 months ascorbic acid preparations supply more ascorbic acid than does the diet. After two years the Recommended Allowance is approximately at the 25th percentile of observed intake from diet alone.—*Wistar Institute.*

5. Bendig, A. W. The comparative reliability of double and single rating scales. *Journal of General Psychology,* **57:** 197-201 (Oct. 1957).

A single rating scale is one which ranges from the least desirable at one end to the most desirable at the other end. A double scale has the most desirable rating in the center with both ends representing undesirable qualities. In this study, four instructors of a psychology course were rated by 46 graduate students on 13 five-point scales. Eight were single scales and five were double scales. It was found that the double scales gave a more symmetrical distribution of ratings and that the ratings had a smaller standard error of measurement.—*Bruce L. Bennett.*

6. Braun, Harry, and A. W. Bendig. The effect of addition of irrelevant verbal cues on perceptual motor learning. *J. Exp. Pysch.,* **54:** 2 (Aug. 1957).

To investigate the effect of high-meaningful and low-meaningful irrelevant verbal cues on the acquisition of a perceptual motor skill the writers constructed an apparatus that might be broadly classified as an electromaze. They used as subjects 55 male and female undergraduate students who were enrolled in psychology classes at the University of Pittsburgh. For cues they selected 11 high-meaningful words such as captain, money, and office, and 11 low-meaningful words such as latuk, quipson, and rumap. The subjects had to learn 11 random sequences of button pushes.

The writers concluded that the acquisition of the skill was facilitated by the addition of verbal cues, but that there was no significant difference between the effect of high-meaningful and that of low-meaningful cues; and that performance of the task was related to the level of motivation as measured by Edwards' Need Achievement Scale, but not to verbal ability or level of manifest anxiety.—*Edna Willis.*

7. Callaway, J. Lamar, and Sidney Olansky. Trimeprazine: an adjuvant in the management of itching dermatoses. *North Carolina Med. Journal.*

Of 85 patients with skin conditions in which pruritus was the chief symptom, 84 got some degree of relief after use of trimeprazine as an oral adjuvant in the managment of the dermatoses. Results were judged excellent in 24, good in 46, fair in 13, and poor in 1. The only side effect noted in this series was drowsiness, which, in general, can be overcome by adjusting dosage. In many instances tolerances increased as the medication was continued.—*Medical Abstract Service.*

8. Feigenbaum, Harry. Colloidal oatmeal for skin eruptions. *Journal of the Med. Soc. of New Jersey.*

After observing its effects on 32 patients with various hand eruptions, the author concludes that colloidal oatmeal in petrolatum base appears to meet all the criteria for a cleansing agent where inflammation or chronic skin eruptions contraindicate ordinary soaps. These criteria are (1) mildly acid or neutral in reaction; (2) non-irritating; (3) acceptable to patient; (4) it should not appreciably remove the normal se-

baceous coating, particularly in dry, eczematous eruptions. Of the 32, 17 who previously had been using soap were changed to Aveeno Soap Substitute showed significant decrease in erythema, edema, and oozing. In all cases the regimen remained unchanged except for the new cleansing agent. Of the total number, 29 (91%) found the colloidal oatmeal-petrolatum product easy and convenient to use except when the hands were very dirty. In general, it was acceptable for prolonged use. Three patients did not like the product. One of these did not like any of the soap substitutes because he thought they did not cleanse as well as soap. The other two preferred a liquid type of soap substitute. None felt that the collodial oatmeal in the petrolatum base was irritating to the skin or excessively greasy.—*Medical Abstract Service.*

9. Fenn, Wallace O. The mechanics of standing on the toes. *Am. J. Phys. Med.*, **36:** 153 (June 1957).

The author discusses the literature and research that has been done on the mechanics of standing on the toes and suggests that the psychological aspects, including voluntary and reflex nervous mechanisms, have not been adequately investigated or considered. He points out that the throwing of the body forward before rising on the toes is only to maintain balance, and is not necessarily a mechanical accompaniment of the gastrocnemius muscle in raising the heel. Other similar examples are given. —*C. Etta Walters.*

10. Godfrey, George C., and Joseph M. Miller. Treatment of impaction of feces with an enema containing an enzyme. *U.S. Armed Forces Med. Journal.*

While soapsuds enemas, retention enemas of warm olive oil, or solutions containing small amounts of hydrogen peroxide occasionally are beneficial in treating impacted feces, often required are procedures such as digital manipulation to break up the mass or some type of enema more effective than those mentioned above. By experimentation and clinical trial, the authors established to their satisfaction that certain enzyme-containing solutions are effective in fragmenting the hardened stool, which is then washed out by the liquid vehicle. A solution of 5.0 grams of Caroid or of 0.13 gram of crystalline papain in 300 ml. of a warm aqueous solution of Zephiran Chloride was found to be safe and effective when used as an enema.—*Medical Abstract Service.*

11. Hawthorne, Betty Elleen, Wilma D. Brewer, and Margaret A. Ohlson, Metabolic patterns of a group of overweight, underweight, and average weight women. *J. Nutrition.*

Possible biochemical differences in the metabolism of fat and carbohydrate among overweight, average weight, and underweight women were studied before and following two test meals of varying carbohydrate and fat composition. Observations on 21 women included total oxygen consumption, blood pyruvic acid, blood glucose, serum chylomicron counts, and serum total lipids. Variations of individual subjects within the overweight, underweight, and average weight groups indicated that no single metabolic pattern was associated with the condition of overweight or underweight. However, as a group, the overweight women appeared to exhibit a delay in the utilization of carbohydrate as compared with the underweight subjects. Chylomicrographs of the overweight women following the high-fat test meal differed from those of the underweight women. The ratio of fasting blood pyruvic acid to fasting blood glucose was higher among the overweight and lower among the underweight subjects than for the average weight subjects. Cumulative calorie increments following the high-fat test meal were significantly higher for the underweight subjects than for the overweight subjects. This variation in metabolic responses between groups appeared to be greater than variations among individuals within groups.—*Wistar Institute.*

12. Kaunitz, Hans, Charles Albert Slantez and Ruth E. Johnson. Utilization of food for weight maintenance and growth. *J. Nutrition.*

Food requirements for weight maintenance and weight increase were determined by

measuring the food intake of rats kept at constant weight by restricted feeding of a complete, purified diet and the food intake and weight increase of well-matched rats permitted to eat freely. The requirements for weight maintenance were found to be influenced by the duration of food restriction, the body weight, and the room temperature but hardly by the age. Prolonged food restrictions led to a reduction of about 30% in the maintenance requirements. Food requirements for weight increase did not seem to be influenced by the above factors; approximately one gram of food was necessary to build one gram of body substance under widely different conditions. The implications of these studies for problems of food utilization and for paired weighing and paired feeding techniques are discussed.—*Wistar Institute.*

13. KEYS, ANCEL. Calories and cholesterol. *Geriatrics,* **12:** 301-310 (May 1957).

A review is made of the studies concerning cholesterol and coronary heart disease. An indication is seen that the differences between population in the incidence of coronary heart disease and mortality at given ages are not explained by race, climate, obesity, activity, emotions, or heredity. The freqeuncy of coronary heart disease appears related to the average serum cholesterol concentrations of populations. No relation between cholesterol and protein is found but a close correlation is seen with the proportion of fat in the habitual diet. When diet fat proportions change, a time lag of 1 or 2 years is seen in ischemic heart disease frequency. The influence of dietary fat probably operates through atherosclerosis and thrombosis. Different diet fats act differently, however. The common meat and dairy fat of America raise the serum cholesterol. Unsaturated and linoleic acid fats lower the cholesterol. Any addition of corn oil to the American diet is of little value unless reduction in ordinary fat also occurs. In fact, additions of anything to the diet without other fat reduction seems useless in controlling coronary heart disease—*E. D. Michael.*

14. KOTTENHOFF, HEINRICH. Situational and personal influences on space perception with experimental spectacles. *Acta Psychol.,* **13:** 79 (1957).

The author summarizes studies that have been done on animals and humans wearing field-inverted spectacles and other variations of distortions of the normal visual field. There seemed to be an increase in adjustment as the phylogenetic scale was ascended. Observations reported by humans showed conflicting results. When tests were applied in a laboratory environment, the "pre-experimental visual world" was most dominant, and when active participation involving everyday activities was applied, the old memory patterns decreased more and the erection of new "visu-spatial" worlds in relation to the inverted field was favored—*C. Etta Walters.*

15. LYON, JOHN B., JR., Muscle and liver glycogen of mouse strains susceptible or resistant to nutritionally induced obesity. *American Journal of Physiology,* **187:** 415-416 (Dec. 1956).

Four strains of mice were raised on commercial stock rations and diaphragm and liver glycogen were determined in ages up to 1 year. The diaphragm was excised first since the liver removal caused depletion in diaphragm glycogen while the liver was not affected by the diaphragm removal. The susceptibility to nutritionally induced obesity in one strain was accompanied by low levels of muscle glycogen and high levels of liver glycogen.

The findings indicate endocrine patterns differ in the groups susceptible to obesity and suggest a greater output of insulin or a greater peripheral activity of the hormone. Since there was a low food intake, a low rate of growth and high nitrogen excretion with this group, the interpretation is not entirely valid. Neither does it seem that increased levels of a glycostatic factor such as a growth hormone is entirely valid with such growth patterns.—*E. D. Michael.*

16. MCCARTHY, M. D., *et al.* Anemia in relation to survival following thermal injury in the rat. *American Journal of Physiology,* **189:** 6-10. (April 1957).

White rats were given thermal injury consisting of burns covering 20%, 32%, and

50% body surface. Hematocrits, erythrocyte, and reticulocyte counts were obtained before and following the burns in the experimental and unburned control group. In the 50% burned group, erythrocyte counts dropped 60% in 24 hours. The count of the 24 week survival group dropping to 53% of the pre-burn period in 48 hours, then increasing to 96% pre-burned level and in 3 weeks a secondary oligocythemia developed and remained. In the 32% group the erythrocyte count dropped to 62% of the pre-burn value in 48 hours then increased gradually. At 4 weeks the secondary oligocythemia occurred, recovered again then regressed at 24 weeks. In the 20% burned group the erythrocyte counts dropped to 67% of the pre-burn level at 24 hours and in 1 week showed only mild oligocythemia followed by steady recovery. The erythrocyte levels of control rats who were bled 3 ml. dropped to 77% and in 1 week returned to initial levels and finally to 140% values. Most deaths occurred during erythrocyte increase. The trend for the first 168 hours is similar for the animals dying within 3 weeks and for the survival group.

The average hematocrits paralleled the red cell counts in all the animals. The reticulocytes decreased in burned groups for 24-48 hours then increased to a peak at 96 hours at a slower rate then the decrease in the erythrocytes. In the 50% burned group the reticulocytes returned by 3 weeks and increased again after secondary oligocythemia. The 32% group showed a secondary increase in reticulocyte level corresponding to a second oligocythemia. With the 20% group the reticulocyte returned in 2 weeks and remained. Comparison of the experimental and control groups shows reticulocyte increases at 96 hours similar for burned and bled groups.

It was evident that thermal injury did not cause a complete inhibition of erythropoiesis. There was no marked difference in degree of anemia or percentage increase in reticulocytes in those rats dying or surviving indicating anemia per se didn't cause the death. Only the 32% of 50% burned survivors had red cell counts depressing in 2-4 weeks. Since the reticulocyte counts were elevated in this period the indication is that a hermolytic toxin is partially responsible for red cell destruction and supression of the marrow.—*E. D. Michael.*

17. Moonan, William J. A quick and dirty method for estimating multiple correlations. *Journal of Educational Research,* **25**: 4: 339-343 (June 1957).

An arithmetically simple procedure for estimating multiple correlations was found. It was empirically shown that the estimate provided a "practically" precise, in respect to the maximum likelihood estimate, in most cases. The method does not take into consideration the pattern of the intercorrelations among the independent variables, but merely utilizes their average value and their number. The method is less exact as the heterogenity of the intercorrelations among the independent variables increases—*D. B. Van Dalen.*

18. Morton, Daniel G. Use of estrogens in menopausal symptoms. *Chicago Med. Soc. Bull.*

Estrogens, administered with a certain amount of caution, are, in the opinion of the author, distinctly useful when indicated to control menopausal symptoms. Properly supervised, estrogen therapy in the dosages given for these conditions probably offers slight danger of carcinogenic activity. Cancer induced experimentally in animals by this means has resulted from massive doses. In this section, excerpted from a wider discussion of hormone therapy in gynecology, the author discusses indications, dosage schedules, and abuses of estrogens in those patients in whom such therapy is indicated. —*Medical Abstract Service.*

19. Rose, D. L., S. F. Radzyminski, and R. R. Beatty. Effect of brief maximal exercise on the strength of the quadriceps femoris. *Arch. Physic. Med and Rehab.,* **38**: 157-164 (March 1957).

Exercise consisted of leg extension to 180° with a maximum load and holding it for five seconds, once a day, five days a week. Each day the load was increased by

1¼ lbs. A load plateau, 80% to 400% higher than the initial one, was reached in about eight weeks. There was no increase in the girth of the exercised leg. This plateau was maintained for 28 weeks with an exercise once a month. Weekly tests revealed a cross-education phenomenon on the non-exercised leg in all normal subjects. The effect was sometimes equal to that obtained on the exercised limb. Limbs immobilized by a cast showed no cross-education phenomenon. This was no correlation between initial strength and final strength or the time of reaching the plateau.—*Peter V. Karpovich.*

20. Salber, Eva J. The effect of sex, birth rank, and birth weight on growth in the first year of life. *Human Biology,* **29:** 2: 194-213 (May 1957).

An analysis of the above factors was made on four racial groups attending municipal child welfare clinics in Durban. It was found that: (1) boys weights are higher than those of girls through the first year of life. (2) European boys grow consistently faster than girls. (3) Non-European boys grow faster than girls in first 6-8 months of life, but girls grow faster thereafter. (4) First born babies of both sexes start off lighter than later born babies, but overcome them during the first year. (5) In European, colored, and Indians the difference in rate of growth between the ranks is greater for girls than for boys, but in the Banter it is greater for boys. (6) Heavier babies at birth remain heavier throughout the year than babies who are lighter at birth. (7) Birth weight has no effect on gain in weight. (8) Babies double their birth weight before 6 months of age.—*D. B. Van Dalen.*

21. Scarf, Robert C. Differential scores and unstable personality. *Journal of Educational Psychology,* **48:** 5: 268-272 (May 1957).

The psychological examination, published by the American Psychological Association, was found to be a fairly good prognostic device. It is possible to use the examination to say which freshman will have personality defects, or neurotic and unstable personalities, but it is useless as a predictor of psychotics.—*D. B. Van Dalen.*

22. Shatin, Leo. Some psychological aspects of long term hospitalization. *Mental Hygiene,* **41:** 487-96 (Oct. 1957).

The author is chief clinical psychologist of a Veterans Administration Hospital. He describes a pilot project to treat aged chronic mental patients in a general medical and surgical setting. Along with group psychotherapy, electroshock therapy, and other therapeutic methods, extensive use was made of recreational and special services. Special services were used as a definite treatment modality and contributed a great deal to the rehabilitation of patients whose prognosis was poor.—*Bruce L. Bennett.*

23. Sparkman, Robert S. Gall stones in young women. *Annals of Surgery.*

Despite evidence to the contrary, the impression persists that gallstones are an affliction of middle or advanced years. In a series of 100 consecutive female patients seen by the author, the largest number of cases (23) accurred in the 22 through 30 age group. Moreover, says the author, if all the patients had undergone operation in the early period of their symptoms, the incidence curve for the decades probably would have shifted toward the younger groups. In this paper the author concentrates on the 23 patients who were in their third decade, discussing general symptomatology, treatment, relationship of pregnancy to stone formation, and related data. Errors in diagnosis are not uncommon since manifestations of gallstones in younger women may differ from symtoms in later years. The author concludes that since the mortality and morbidity of biliary tract surgery increase with the age of the subject and the duration of symptoms, the young patient is the ideal candidate for cholecystectomy. Earlier recognition and treatment are the key to reduction of morbidity and mortality.—*Medical Abstract Service.*

24. Wells, Ralph F., and William W. Stead. Determining the activity of pulmonary tuberculosis. *Minnesota Medicine.*

After a study of 203 patients (96 active minimal, 107 moderately advanced) the authors conclude that history, physical examination, and routine office laboratory procedures, such as white blood-cell count and sedimentation rate, may be seriously inadequate in evaluating the patient with an abnormal chest film. Of the 96 cases of active minimal tuberculosis, 71% were asymptomatic; 71% had no physical findings; 85% had a normal sedimentation rate; 93% had negative initial bacteriology and 23% remained bacteriologically negative. If dismissed when first seen, 60% of these patients would have been judged inactive. Only by culture of the sputum or (more often) gastric contents, or by means of serial films, was activity proved. Of the 107 cases of moderately advanced disease, 38% were asymptomatic; 48% had no physical findings; 42% had a normal ESR; and only 23% had positive initial bacteriology. Cavitary disease was present in 75%, and 73% in this latter group had negative sputum smears. Of the 107 moderately advanced cases, 16% would have been judged inactive by routine work-up. The authors emphasize that repeated attempts to get positive bacterial proof by culture technic plus the study of serial films will incerase the discovery rate. —*Medical Abstract Service.*

25. Yeomans, William N., and Robert W. Lundin. The relationship between personality adjustment and scholarship achievement in male college students. *Journal of General Psychology,* **57**: 213-218 (Oct. 1957).

The Minnesota Multiphasic Personality Inventory was administered to the top and bottom scholastic quarters of both the freshman and senior classes at Hamilton College to determine the relationship between personality adjustment and scholastic achievement. There were three main conclusions. (1.) The poorer students did show a greater degree of maladjustment. The authors felt these students were poorly motivated, irresponsible, and too active in other affairs to devote adequate time to study. (2). Men in the top scholastic quarter showed a greater feminine interest than that found among men in the general population. This interest was probably expressed in a greater orientation toward academic pursuits, especially in aesthetic and philosophical areas. (3.) The freshmen generally showed poorer adjustment than the seniors. This is probably a temporary situation which will improve as they adjust to college life.—*Bruce L. Bennett.*

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